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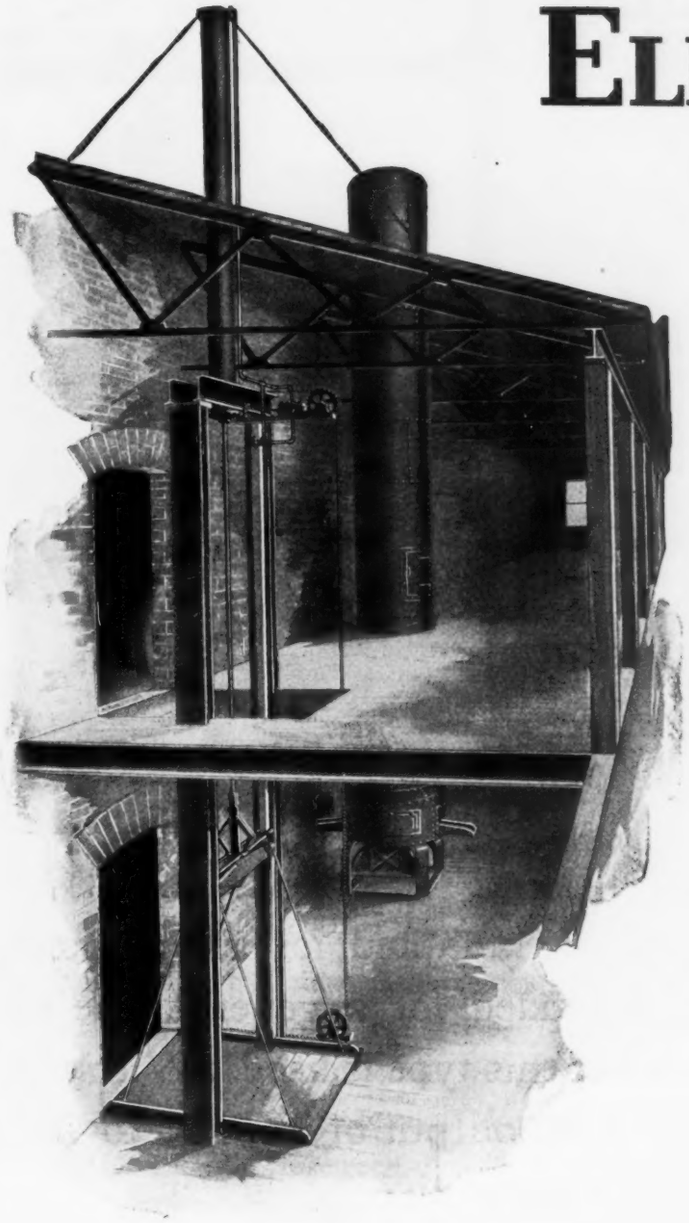

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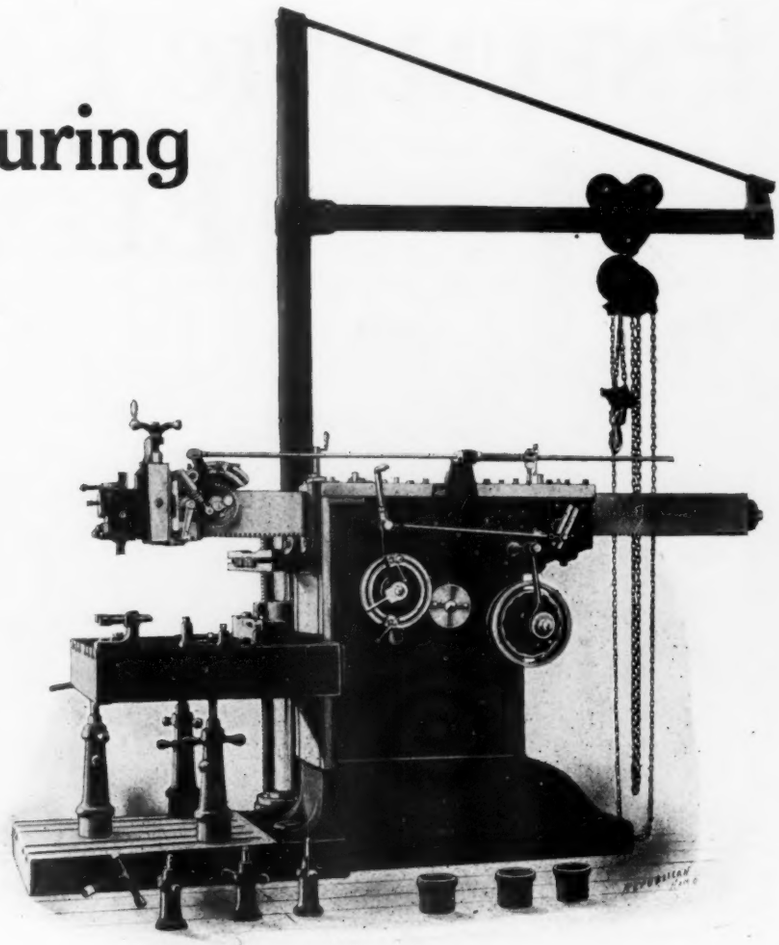

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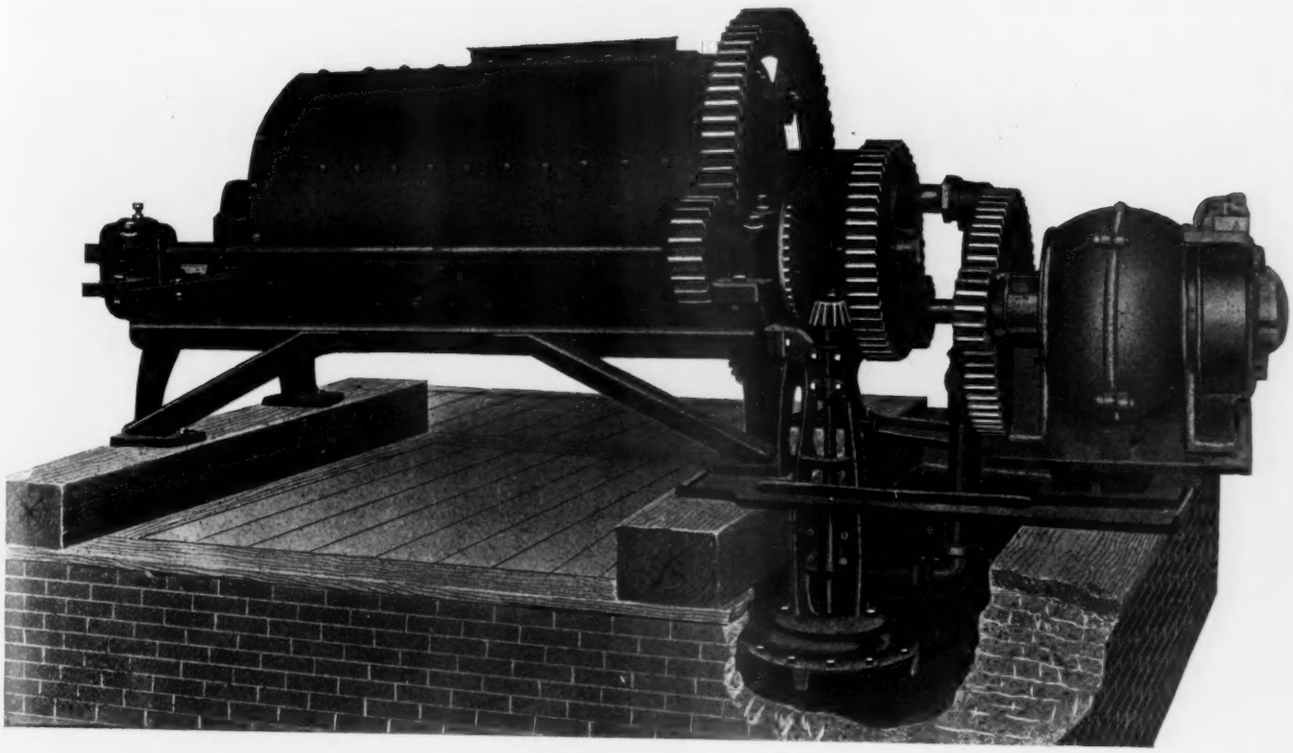

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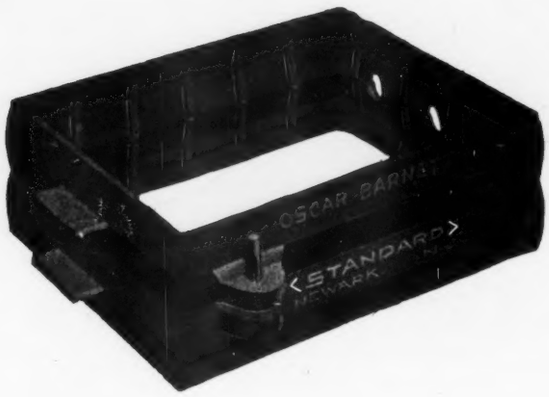

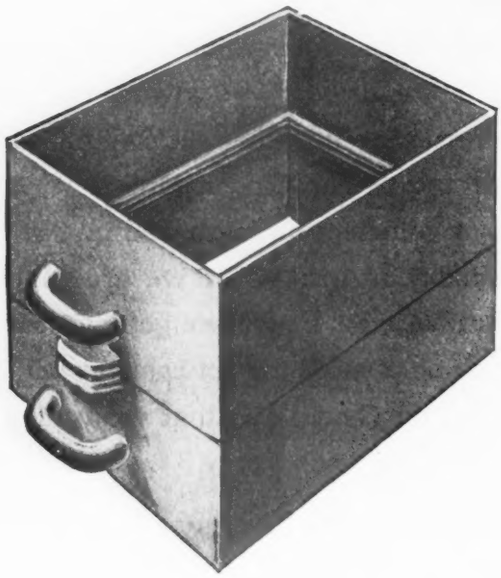

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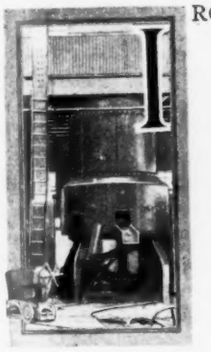
THE FOUNDRY

Vol. 31, No. 2 CLEVELAND, OHIO, OCTOBER, 1907 Whole No. 182

MELTING IRON FOR CASTINGS

Discussion of Cupola Practice—Methods of Charging and Calculating Mixtures—Tuyere Area—Fuel

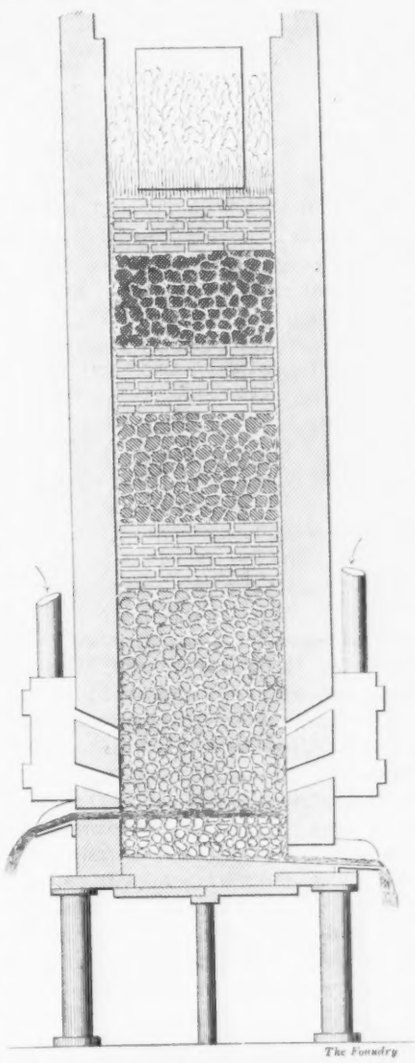
BY BRADLEY STOUGHTON



IRON for castings is melted either in the cupola or the air furnace, although sections made from the metal just as it comes out of the blast furnace, known as direct castings, are used in many cases, and especially for cast iron ingot molds in steel works. There are experts who are able to judge by eye the character and the analysis of the molten iron as it flows from the furnace, and this is necessary where direct castings are to be made because the metal may vary greatly and without warning, from one cast to another.

The Cupola Furnace.

The design and principle of operation of the cupola furnace bears some similarity to that of the blast furnace, the chief difference being that the coke of the cupola furnace is desired only for its melting influence, and the only chemical reactions are minor and unintentional. The cupola is the cheapest method of melting metals because there is direct contact between the metal and fuel and therefore the maximum absorption of heat. The amount of the fuel consumed varies from one-fourth to one-twelfth of the weight of the iron melted, the former average being reached when exceedingly hot metal is desired—as for example, for very small castings for malleable work—and the latter figure when the melting is continued for several hours and the metal is not made very hot, but is to be poured into large castings. The cupola should be so operated that certain well defined zones of action are maintained in order that rapid, hot and economical melting may be obtained and loss by oxidation may be small. The zones of action which I have mentioned as being so important in this connection are, beginning at the bottom of the cupola and going upwards: (1) the crucible zone or hearth; (2) the tuyere zone; (3) the melting zone, and, (4) the stack. The cupola is filled with alternate layers of coke and iron, as shown in the accompanying illustration, except when starting up and blowing out, and the different zones are produced by the action of the blast and the heat upon these different layers. The thickness of the layers are the same regardless of the cupola diameter.



CUPOLA SHOWING ALTERNATE LAYERS OF COKE AND IRON

Crucible Zone.

The crucible zone extends from the bottom of the cupola to the level of the tuyeres. The sole object of this is to form a place in which the iron and slag may collect after they have melted and trickled down to the bottom. If the tap-hole is kept open all the time and the metal allowed to flow out of the cupola and collect in an outside ladle as fast as it melts, the crucible zone will be very shallow and the tuyeres should be placed not more than two to five inches above the bottom. If, on the other hand, the crucible is used as a reservoir for a large amount of metal, the tuyeres are placed correspondingly high. Hotter metal may be obtained by collecting the iron in an outside ladle, where it will not suffer the cooling action of the cold blast blowing upon it from the tuyeres.

Tuyere Zone.

The tuyere zone is the place in which the blast comes in contact with and burns the red hot coke. It

is the zone of combustion, and all the heat of the operation should be produced in this place. It is, of course, situated near the tuyeres and wherever the blast may come in contact with coke. As there is always a column of coke extending from the melting zone to the very bottom of the cupola, combustion will begin immediately above the reservoir of melted metal, if any, because the pressure of the blast drives the air downwards as well as upwards. The upper limit of the combustion zone will depend upon the pressure of blast, because the greater the blast pressure, everything else being the same, the higher will it extend its zone of combustion. The blast pressure should be such, however, that the top of the tuyere zone, or zone of combustion, should never be more than 15 to 24 inches above the uppermost tuyeres.

Table I.

Analysis of Cupola Gases Taken from Three to Four Feet Below the Charging Door.

Time elapsed since blast was put on.	Analysis by Volume. Oxygen, O.	Carbonic dioxide, CO_2.	Carbonic Oxide, CO.	Nitrogen (by difference) N.	Ratio CO_2 is to CO as 1 is to:
10 minutes	0.0	13.8	9.9	76.3	0.717
1 hour 13 minutes	0.0	9.5	16.9	73.6	1.780
2 hours 17 minutes	0.4	9.2	16.6	73.8	1.804
3 hours 13 minutes	0.0	6.7	21.7	71.6	3.239
4 hours 15 minutes	0.1	7.8	22.3	69.8	2.859
38 minutes	1.8	7.6	15.5	75.1	2.04
1 hour 42 minutes	2.8	7.5	13.3	76.4	1.77
2 hours 50 minutes	1.9	7.1	15.8	75.2	2.225
3 hours 40 minutes	0.1	7.2	19.0	73.7	2.64
38 minutes	0.0	10.2	14.6	75.2	1.431
3 hours	2.9	5.4	14.3	77.4	2.65
10 minutes	0.2	13.1	7.7	79.0	0.588
3 hours 10 minutes	0.3	10.3	11.7	77.7	1.136
50 minutes	0.0	7.1	15.4	77.5	2.17
1 hour 40 minutes	0.0	8.3	13.5	78.2	1.626
2 hours 40 minutes	0.0	8.2	12.1	79.7	1.475
3 hours 40 minutes	0.0	6.0	15.0	79.0	2.50
45 minutes	0.0	13.0	12.6	74.4	0.97
1 hour 40 minutes	0.0	13.0	11.2	75.8	0.862
2 hours 40 minutes	0.0	8.2	20.0	71.8	2.44
3 hours 50 minutes	0.4	6.0	22.1	71.5	3.683
4 hours 43 minutes	1.2	5.1	21.2	72.5	4.157
1 hour	0.0	9.8	15.4	74.8	1.571
1 hour 53 minutes	0.0	9.1	16.8	74.1	1.846
2 hours 45 minutes	0.0	8.8	16.8	74.4	1.91
3 hours 45 minutes	0.0	7.5	19.7	72.8	2.627
4 hours 45 minutes	0.0	7.5	18.7	73.8	2.5000
Another Cupola.					
30 minutes	0.1	16.7	7.3	75.9	.437
1 hour 30 minutes	0.1	13.1	10.7	76.1	.817
2 hours 38 minutes	0.4	11.8	11.0	76.8	.932
3 hours 20 minutes	0.0	12.8	7.7	79.5	.602

Melting Zone.

The melting zone is the space in which all the melting of iron takes place. It is situated immediately above the tuyere zone. During the melting the iron is supported on a column of coke which extends to the bottom of the cupola, and which is the only solid material below the melting zone. When each layer, or "charge," of iron enters the melting zone it should be about 15 to 24 inches above the uppermost tuyeres. As fast as it melts it trickles down over the column of coke to the bottom. It takes about five to ten minutes for each layer of iron to melt, however, and during this time the column of coke is burning and sinking. Therefore, the last of the iron will melt at a point about seven inches lower down. Consequently the melting zone overlaps on the upper limit of the zone of combustion. If the layers of iron and coke are properly proportioned to the pressure of blast, each charge of iron will enter the top of the melting zone just before the next previous charge is completely melted at the bottom, and thus a continuous stream of iron will collect in the crucible, or run from the tap-hole. The coke burned from the column will also be exactly replenished each time by the layer of coke coming down, and the position of the melting zone, which is the important consideration, will be maintained within constant limits.

The actual position of the melting zone may always be learned when the cupola is emptied, because the iron oxide formed there will corrode the lining, which will therefore be cut away somewhat at this point. Corrections may then be made, if necessary, in the next charge of the cupola.

Stack.

The stack extends above the melting zone to the level of the charging door. The function of this part of the furnace is to contain material which shall absorb heat and thus prepare itself for the actions at lower levels, and also shall keep the heat down in the melting zone as well as possible.

Tuyeres.

The blast enters the cupola through the tuyeres, of which there are usually one or two rows and sometimes more. The position of the upper row of tuyeres determines the position of the melting zone in the cupola. Two rows of tuyeres give faster melting in the cupola than one row but cause greater oxidation and more fuel is required on the bed, as the melting zone is higher in the cupola.

Blast.

The blast pressure will depend somewhat upon the size of the cupola, but present practice is overwhelmingly in favor of pressures not exceeding a pound, even for the very largest cupolas, and diminishing to a half a pound or so for the smaller sizes. The common type of blower used in America is of the two-impeller type. It takes about 60 cubic feet of air to burn a pound of coke, from which may be calculated the size of blower necessary for each cupola, allowing about 50 to 100 per cent excess for leaks and incomplete combustion. Makers of cupolas and blowers give all the necessary data in their catalogs, but advocate too high blast pressures and volumes. If the blast volume is too large, or the pressure is too great, the position of the melting zone will be too high. This means that the bed of coke must be larger to reach to the upper level of the melting zone, which is wasteful. It also means that the melted iron will have a greater height to drop through. It therefore oxidizes more, corrodes the cupola lining more, and consequently causes more waste of iron and more slag. The volume of blast is the most important consideration, but this is difficult to measure, so the pressure is the factor that enters into the calculation. It must be remembered, however, that this is only a makeshift arrangement at best.

Cupola Charge.

In the cupola is first placed shavings and wood, on top of which is placed the bed of coke, which should be large enough to reach 15 to 24 inches above the uppermost tuyeres after the kindling is burned. On top of this is placed a layer of metal about six inches thick, then a layer

of coke about seven inches thick, another layer of iron and so on. The actual weight of the coke for the bed and of coke and iron for each charge will therefore depend directly upon the diameter of the cupola inside the brick lining, which varies from about 32 to 120 inches, or even more in some cases. The weight of the coke in each layer will be about one-sixteenth to one-twelfth of the weight of iron in each layer. The tuyeres and the front of the cupola around the tap-hole, known as the breast, are left open for an hour or so after the kindling is lighted, in order that the draught may draw air in at the point for combustion. When the kindling is thus burned off and the bottom coke well lighted, the breast is closed and the wind turned on. It is very necessary that the bed should be well lighted and level.

Cupola Melting.

The heat generated by the combustion of coke begins to melt the iron and in less than 15 minutes after the wind is put on the metal should begin to run from the open tap-hole. If it takes longer, then the coke bed was too high and wasteful. In another eight to ten minutes the first layer of iron should be entirely melted. Now the second layer of iron lies upon the column of coke, whose top should again be the original distance above the uppermost tuyeres. If the layers of coke are too thick there will be a delay in the iron entering the melting zone and the extra coke burned will not have been used with the best efficiency. If the layers of iron are too thick the last of the layer will melt too near the tuyeres, which will oxidize it excessively and make it cold. This can be observed during the run by noting if the iron runs first hot and then cold. It is very important to watch the flame that comes off the top of the stock in the cupola. When the blast volume is too large this flame will be "cutting," that is, oxidizing in character. Too great oxidation may also be observed if sparks of burning iron are projected from the slag-hole. If the layers of iron and coke are both too thick there may be a correct relation between the weights of the two but both of the irregularities mentioned above will be observed. If the layers of iron and coke are both too thin we will have two charges of iron in the melting zone at the same time, and this may be learned by watching the iron from the tap-hole, because it will run sometimes faster than at other times. This does not produce such bad results, however, as having the layers too thick. Of course, if very hot iron is required it will be necessary to have thicker layers of coke and slower melting must be expected.

Chemical Changes.

As the iron drops down over the coke, it absorbs sulphur, the exact proportion depending chiefly upon the relative amount of coke and iron used and the per cent of sulphur in the coke. It will vary from 0.020 to 0.035 per cent of the iron. If the pig iron charged contained 0.08 per cent sulphur, there will be 0.100 to 0.115 per cent in the castings. The sulphur in the first iron will be higher than in that of the middle of the run, because of the extra amount of coke burned before the iron begins to come from the tap-hole. The last iron will also be somewhat higher in sulphur, because there is a greater loss of metal during the last of the run, when the oxidizing conditions are more intense, and therefore a concentration of sulphur. The best practice is to cut off blast progressively as there is less and less material in the cupola.

In many foundries it is customary to charge limestone, in the form of oyster shells, marble chippings, or crude limestone, and sometimes with it a little fluorspar, CaF_2, into the cupola. The amount of limestone varies greatly, but will average perhaps one-half to 1½ per cent of the weight of the metal. This limestone fluxes the dirt on the metal and the ash of the coke and carries off some sulphur in the slag. Fluorspar makes a somewhat more liquid slag than limestone alone and the more liquid slag is believed to absorb a little more sulphur, and also to make the cupola drop more easily, but has a greater cutting effect on the lining.

As the metal melts and falls from the melting zone down in front of the tuyeres, it is subject to oxidation, which carries iron oxide into the slag and also burns up silicon. The melted metal therefore contains from 0.25 to 0.40 per cent* less silicon than the original pig. In other words, if the mixture charged contains 2.25 per cent of silicon, the castings will contain 2.00 to 1.85 per cent silicon.

Cupola Gases.

The gases coming out of the top of the cupola charge consist principally of nitrogen from the air, while the remainder is carbon dioxide, CO_2, and carbon monoxide, CO, with sometimes a little free oxygen. The latter is evidence of a cutting flame and shows too great oxidation in the melting zone. Such a flame may be recognized by the eye after a little practice. It is sharper looking than a richer flame and burns close to the top of the stock. One can identify it exactly by holding an iron rod in it for a while. After the iron becomes red hot it will oxidize much more rapidly in a cutting flame than in a reducing flame. A reducing flame will usually not burn until it becomes mixed with the air sucked in at the charging door. All the carbon monoxide that goes out of the charge represents incomplete combustion and a waste of heat. It seems to be impossible to prevent this, however, just as in the blast furnace whose operations cupola melting resembles in some general respects. Several analyses of cupola gases are given in Table 1.

Table II.

Tabulation of the Material to be Charged and Method of Figuring the Mixture.

Material.	Weight, pounds	Analysis. Silicon Per ct.	Sulphur Per ct.	Phosphorus Per ct.	Manganese Per ct.	Weight of* Silicon Per ct.	Sulphur Per ct.	Phosphorus Per ct.	Manganese Per ct.
Steel scrap	200	0.10	0.070	0.10	0.60	0.2	0.14	0.2	1.2
Machinery scrap	1,000	1.70?	0.100?	1.00?	0.60?	17.0	1.0	10.0	6.0
High sulphur Southern.	800	0.70	0.100	1.50	0.30	5.6	0.80	12.0	2.4
X No. 1 .t.....	800	3.00	0.030	0.80	1.25	24.0	0.24	6.4	10.0
No. 3 foundry.....	2,400	1.75	0.070	0.30	0.60	35.0	1.40	6.0	12.0
High silicon Bessemer.	400	2.50	0.025	0.07	0.60	10.0	0.10	0.3	2.4
Total weight	5,200					91.8	3.68	34.9	34.0
Average per cent†...						1.77†	0.071†	0.67†	0.65†

* Multiply the weight of each kind of material by the per cent of the element in it.
Divide each total weight of element by 5,200 pounds.

Loss.

The loss in melting will average from 2 to 4 per cent and is made up of the silicon burned and the iron oxidized and carried away in the slag. There are other sources of loss in the foundry, such as a second loss of metal remelted, including sprues, risers, etc., which go back to the cupola in the form of scrap; metal spilled during pouring which

*With good practice the loss should not be more than 0.30 per cent silicon.

may amount to as much as five or six per cent more, etc. In some foundries it is customary to pass the used floor sand through a magnetic concentrator, in order to recover the pellets of iron spilled during pouring, and important economy is sometimes obtained in this way. The total loss, namely, the difference in weight between pig iron bought and castings made, will probably range from seven to eight per cent of the weight of the iron bought.

Scrap Used in the Cupola.

Scrap iron is often mixed with new pig iron for the manufacture of castings, both for the sake of economy and because the scrap iron has a somewhat closer grain, or texture, which increases the strength of the mixture. The amount of scrap used will depend upon the materials to be manufactured. Cast iron pipe is frequently made without scrap, this industry amounting to about 500,000 to 800,000 tons per year in the United States alone. Stove foundries, on the other hand, use a very large amount of scrap as a rule, and jobbing foundries, in general, probably use an average of 30 to 40 per cent of outside scrap, besides the gates, sprues, bad castings, etc., made in their own plants.

Cupola Run.

The campaign of an ordinary foundry cupola is from one to four hours. Generally the kindling is started about noon and allowed to burn with a natural draught until shortly after one o'clock when the breast is closed and the blast put on. Metal is then received until four or five o'clock in the afternoon when the last charge is melted. The supports are then pulled out from underneath the door closing the bottom of the cupola and the sand bottom, slag, coke, etc., left in the cupola is allowed to drop and is quenched with water. In order to allow plenty of room for this drop to fall, the cupola is usually elevated above the foundry floor.

Burdening the Cupola.

It should be the duty of the foundry metallurgist or chemist to learn from his records the amount and analysis of all the metal in the yard. Table IV shows a convenient form of this record.

The price should always be in evidence. It should not be the price at which the material was purchased but the market price at which the iron is used. For instance, if a large amount of high grade pig iron had been contracted for the previous year, and if meanwhile the price of pig iron had advanced, the purchase price of that pig iron would not represent its present value. From the current numbers of trade periodicals one can always obtain the prevailing prices for the different grades of iron.

Suppose now with these irons it is desired to burden a 72-inch cupola with a mixture for making heavy hydraulic pumps for which a satisfactory analysis might be 1.60 per cent silicon, 0.70 per cent phosphorus, less than 0.10 per cent sulphur and about 0.50 per cent manganese. The first step is to calculate the cupola charges and the chemist knows by experience with this particular cupola that it will lose 0.25 per cent silicon and 0.10 per cent manganese and it will gain 0.03 per cent sulphur. The average analysis of the mixture put into the cupola must then be 1.85 per cent silicon, 0.70 per cent phosphorus, less than 0.07 per cent sulphur and about 0.60 per cent manganese. The chemist also knows by calculation that about 5.200 pounds of iron will give a layer of the proper thickness in a 72-inch cupola. His problem now is to make such a mixture of the available pig irons that their collective weight will be 5,200 pounds and their average analysis as given above. Moreover if he is a good metallurgist he must aim at using as large an amount as possible of the cheapest materials.

Chemist's Calculations.

He first considers the steel scrap but knows he cannot use very much of this because too much coke would be required for getting iron of the requisite fluidity, but he estimates that five per cent (say 200 pounds) will not increase harmfully the fuel necessary. This figure therefore comes at the top of his list, as shown in Table II. Next he considers the use of machinery scrap, because he knows that his miscellaneous scrap and borings are too uncertain in analysis to be used in a mixture which must give pretty strong and non-porous castings. One thousand pounds of machinery scrap would be about 20 per cent of his mixture and he knows from experience that this is a fairly satisfactory proportion for scrap so that figure is made second in Table II. The low price of the high sulphur Southern pig tempts him, but he

Table III.

Comparative Cupola Practice.

	1	2	3	4	5	6	7	8	9	10	11	A1	A2	A3	A4	
Diameter of cupola, inches	27	35	42	44	54	54	56	58	60	60	72	32	42	44	48	Average
Height of tuyeres from sand bottom, inches	12	7	11	12	7½	14	25	16	2	12	24	11	12	9¼	14	12.6*
Height of charging door above tuyeres, inches	106	120	139	109	103½	113	141	92	112	114	142	133	132	84½	103	116*
Height of charging door above tuyeres divided by diameter	4.0	3.4	3.3	2.5	1.9	2.1	2.5	1.6	1.9	1.9	2.0	4.1	3.1	1.9	2.1	2.5**
Cupola area is how many times tuyere area	3.97	5.66†	9.62	4.53	6.58	5.45	2.85	4.83	10.47†	6.73	5.76	4.96	5.77	7.68	12.56	6.56*
Blast pressure, ounces	9	16	8	9½	13	14	16	16	8	8	13½	16	12	13	8	12*
Class of work made	Job.	Plate.	Light job. & plate.	Boiler plate.	Stove plate.	Boiler & radiator.	Rolls.	Fittings & job.	Plate.	Sanitary & plate.	Electrical.	Gas engine.	Job.	Pumps & job.	Medium light.	
One pound of fuel melts how many pounds of iron	4.0	7.5	7.6	8.8	6.9	7.5	8.3	6.8	7.5	7.6	10.0	6.4	6.2	7.2	7.8	7.3*
	Coke.	Coke.	Coke.	Coke.	Coke.	Coke.	Coke.	Coke.	Coke.	Coke.	Solvay coke.	Light coke.	Coal & coke.	Coal & coke.	Coal & coke.	
Height of fuel bed above tuyeres, inches	20	21	15	33	24	32	40	14	30	22	6†	21	11	25	22.5	22.5*
Thickness of fuel charges after the bed, inches	8.4	7.0	3.8	6.1	6.9	10.4	9.6	8.0	3.8	6.5	7.8	7.3	9.5	3.9	5.8	7.0*
Thickness of iron charges after the bed, inches	3.3	6.5	3.5	6.3	6.3	8.4	8.8	7.3	3.4	6.8	9.0	6.0	7.0	4.7	5.3	6.4*
Time before iron comes after blast is on, minutes	7	15	5	15	10	20	5	15	1	15	15	10	15	15	7	11.3*
Time to melt each iron charge after the bed, minutes	3.25	8.5	5.7	9.0	10.0	11.0	12.0	12.0	5.5	11.0	13.5	7.7		9.5	13.8	9.46*
Total iron melted per minute per square foot cupola area	30.98	23.20	18.19	21.30	18.87	22.64	21.60	18.14	18.80	18.40	20.06	10.2		15.53	11.54	21.11**

†Two rows of tuyeres.
* Including A1, A2, A3, A4.
** Excluding A1, A2, A3, A4.

realizes that he must offset the use of this material by some high silicon low sulphur iron, and in casting about for such a one he naturally first considers the X No. 1. He cannot use much of this either because of its high manganese and it seems reasonable to mix an equal amount of these two. The only question is how much of this mixture will the cupola stand. To get an idea of this he first calculates their average analysis and finds it to be 1.85 per cent silicon, 0.065 per cent sulphur, 1.15 per cent phosphorus and 0.78 per cent manganese. Evidently the phosphorus is the only element in this mixture that gives him difficulty. Indeed if that were not high he could make almost his whole charge up of these two irons and the scrap. The phosphorus in this mixture is 0.45 per cent higher than that of his desired mixture. Therefore he knows that he must use a good deal of No. 3 foundry iron to bring this element down. The phosphorus in the No. 3 foundry iron is about as much below the desired phosphorus as that in the mixture of the high sulphur Southern and the X No. 1 is above it. He must not forget, however, that he has already used 1,000 pounds of machinery scrap containing probably one per cent of phosphorus. Therefore he must use a correspondingly larger amount of No. 3 iron to offset this also.

As a first estimate he therefore considers using 800 pounds of high sulphur southern, 800 pounds of X No. 1 and 2,400 pounds of No. 3 foundry, that is, one and a half times as much No. 3 as the mixture of the other two. But a little reflection tells him that this mixture is going to be too low in silicon, because the mixture of high sulphur southern and X No. 1 only gave 1.85 per cent silicon while the No. 3 foundry and the machinery scrap are both below that. There are then three ways open to him. He may use a little ferro-silicon A, or he may pound up a little ferro-silicon B and dissolve it in the ladle of iron, or he may use a little high silicon Bessemer iron. Either of these methods would do, but the writer would prefer to use the high silicon Bessemer because this will have the effect of cutting the sulphur and phosphorus down and the expense is practically the same. It requires such a small amount of ferro-silicon to give the desired silicon in the mixture that the expense of using it is very small, in spite of its price. Consequently we put down the weights shown in the second column of Table II, and we now figure out the weight of silicon, sulphur, phosphorus and manganese in the mixture by the method indicated there, and the average per cent of each element. The latter figures show us that the silicon is too low, and a simple calculation shows us that we need five pounds more in the total weight of the silicon. We can get this by increasing the amount of either high silicon Bessemer or of X No. 1, and correspondingly decreasing the No. 3 foundry. The high silicon Bessemer has 0.75 per cent more silicon than the No. 3, so it would take (5 pounds ÷ 0.75 per cent =) about 650 pounds change to make up the difference in this way. The X No. 1 has 1.25 per cent more silicon than the No. 3, so it would take (5 pounds ÷ 1.25 =) 400 pounds change to make up the difference with this iron. We naturally would prefer to use the latter, being cheaper, and if we think we can stand all that extra manganese in our castings we probably will do so; if not, we will have to use altogether 1,000 pounds of high silicon Bessemer and only 1,400 pounds of No. 3 foundry. We then make up a new table similar to Table II, and figure out the average analysis as before. It should now come about right.

Comparative Cupola Practice.

After writing the foregoing, which is to form part of a chapter on "Iron and Steel Founding" in a book entitled "The Metallurgy of Iron and Steel," some very valuable figures on "Comparative Cupola Practice" were presented by W. S. McQuillan at the Philadelphia convention of the American Foundrymen's Association. The figures contained therein were of great interest and value (see THE FOUNDRY, July, 1907, pages 370 to 373) and confirm in a striking way the rules I have laid down above. I have copied a part of this table in Table III, and have added several lines to it. I have also had all the calculations in the table checked up by two independent observers.

Fuel.

The first lesson we learn from the table is that a mixture of coal and coke and that inferior coke gives slow melting and a poor fuel ratio. Indeed the work of the cupolas using these grades of fuel is so far inferior to the others that I have separated them in Table III and omitted them from all my calculations except the averages in the last column. After a very careful study of the figures, I am strengthened in the opinion which I have long held and expressed, that a mixture of coal and coke has nothing to recommend it except a deceptive first cost.

Table IV.

Kind	Weight, tons	Si	S	P	Mn	Price
High sulphur, Southern	500	0.70	0.100	1.50	0.30	$ 18.00
High silicon, Bessemer	60	2.50	0.025	0.07	0.60	25.00
X No. 1	100	3.00	0.030	0.80	1.25	24.00
No. 3 Foundry	150	1.75	0.070	0.30	0.60	22.50
Ferro-silicon — A	30	10.00	0.040	0.50	0.10	35.00
Ferro-silicon — B	30	50.00	0.003	0.04	....	105.00
Machinery scrap	100	1.70?	0.100?	1.00?	0.60?	19.00
Miscellaneous scrap	300	1.50?	0.20?	1.40?	0.60?	15.00
Cast iron borings	100	1.50?	0.20?	1.40?	0.60?	11.00
Steel scrap	100	0.10	0.07	0.10	0.60	13.00

Tuyere Ratio.

The next most striking evidence shown by the figures is the relation between the tuyere area and the speed of melting. If we average the iron melted per minute in the cupolas whose area is less than 6.56 times the tuyere area, we obtain a figure of 22.56 pounds; if we get the corresponding figure for the cupolas with lesser proportionate tuyere area, we obtain 18.57 pounds. Indeed so striking is the relation that there is only one exception, namely, cupola No. 8, and we need not look far for a reason for the slow melting in this cupola. It is evidently due to the short height of stack which causes the iron to reach the melting zone before it has been sufficiently preheated. A large proportionate tuyere area evidently means that the wind will pass through the tuyeres with less resistance and a lower velocity. That is to say, we will get more wind and it will not be driven so much to the center of the cupola. If the publication of these figures did no more good than to point out the advantage of the large tuyere area, they would have already contributed a very great deal to the foundry industry. It may be said to be established for the types of practice here

exhibited that the collective area of the tuyeres should not be less than one-sixth and preferably not less than one-quarter of the horizontal area of section of the cupola.

Height of Stack.

There is also an important relation between the speed of melting and the height of the charging door above the tuyeres divided by the diameter of the cupola. The average speed of melting of the cupolas where this ratio is greater than 2.5, is 24.12 pounds per minute, while the average speed of melting of those whose ratio is less than 2.5 is only 19.15 pounds per minute. There are only two exceptions to this rule: (1) Cupola No. 6 is a fast melter, but this is doubtless due to the large proportionate tuyere area. (2) Cupola No. 3 is a slow melter, but this is doubtless due to the very small proportionate tuyere area. With these exceptions the rule is universal and a comparison of different cupolas only strengthens it; for example 4 with 8, the proportionate tuyere area being nearly the same; also 2 with 6, etc. A comparison of 3 with 9 is an apparent exception which is explained by the two rows of tuyeres in No. 9.

Blast Pressure.

The average speed of melting of the cupolas with more than 12 ounces blast pressure is only 20.75 pounds per minute, while that with less than twelve ounces is 21.53. This relation is not so striking as to establish a rule, especially as a single cupola, No. 1, throws such a large influence into the low blast column. Nevertheless the evidence is sufficiently striking to discredit the theory that higher blast pressure necessarily gives faster melting. Indeed if cupolas 3, 9 and 10 had a larger tuyere area, we should expect an average result very favorable to low blast pressure.

Height of Fuel Bed.

The original height of fuel bed is no criterion with which to figure as it in many cases is raised or lowered during the first few minutes of melting, and thereafter occupies some other position. It is the thickness of the fuel and iron charges after the bed which is the important consideration and, as already observed, these should be regulated to about six to eight inches for fuel and six inches for iron, irrespective of the diameter of the cupola. In case hot iron is desired the layer of fuel should be at the upper limit of thickness and vice versa.

Speed of Melting.

The speed of melting is very important because, everything else being equal, the faster the melting per square foot of cupola area the greater will be the efficiency of operation of the cupola, and therefore of economy under given conditions.

SCALE BURNT ON MALLEABLE CASTINGS

BY DR. RICHARD MOLDENKE

NOTHING looks worse in a malleable casting than scale burnt on the recessed surfaces or in the cored portions. This trouble may be caused in two ways. First, the actual burning on of the scale used to pack the castings, and second, the oxidation of the castings themselves in the anneal. The latter again either from the burning of the metal in the furnace, and from currents of air going through the boxes due to imperfect packing or luting up of the joints.

Where it is a simple sticking of the scale, the breaking of a casting will soon show this. If overheated the scale will simply melt on, just like an enamel, there being always some silicate of iron present in the scale, especially if much puddle scale in its original form is present. The remedy of course is to keep the temperature within proper limits. The castings will show distinct signs of overheating, going into the white without the crystalline structure unmistakable to the experienced eye. Where the casting shows up all right, that is, pure black with a thin rim of white distinctly outlined, with perhaps a dark gray band between, the scale has deteriorated badly, that is, contaminated with burnt molding sand from improperly rumbled hard castings which has scaled off, or from the "mud" for luting up the joints between the pots and stool. In this case screen out all the fine material, and throw it away.

Now in the case of trouble with the iron itself. When a heat has been burnt, it will manifest itself in several ways. First, the iron will skull in the ladles. The percentage of molds which were short-poured, that is, had their gates set before being fully poured, will be high. There will be gas holes in the castings, and the product from the anneal will show wide bands of crystalline white, or in extreme cases will not anneal at all. Here we have an iron which is very sensitive to the annealing heat. It will rapidly oxidize on the surface, even if packed with the best of care. Yes, even if packed in sand or fireclay. The result is a skin or coat of oxide scale which may be readily rattled off on the surfaces, but which sticks like grim death in the recesses and holes. Only chipping will improve the appearance of the work. It may be said that in such cases, especially if very bad, that the molding sand burns on the casting right in the foundry, due to combination of oxide of iron and silica at the skin, and this sometimes cannot be removed, even when tumbled all day in the barrel. Naturally this is aggravated in the anneal.

Now if to this trouble there comes the other, of currents of air passing up through the pot by reason of defective luting up, then the coat of oxide produced will be so thick that hammering the casting will flake it all off, and the casting will be lighter, smaller, and have all the edges round. Where the iron was all right, this air circulating in the pots will make a skin of oxide which is discouraging, and hence great care should be taken to have good tight pots, and mud cover. Sometimes the evil is so great that iron tops are necessary to make a better job, and this of course is expensive.

Probably the finest result ever obtained in this connection was with pickled castings. Hydrofluoric acid was used with steam. The castings came from the pickle perfectly clean, and with a heavy coating of rust. After anneal, the iron being good, and the annealing carefully done, the dumping of the pots left the annealed castings a fine blue, absolutely free from the scale, which fell away from the castings easily, and these castings were shipped without the soft rolling.

A MODEL PACIFIC COAST IRON FOUNDRY

Rapid Reconstruction of the Plant of the Olympic Foundry Co., one of the Best Equipped Foundries in the Northwest

BY H. COLE ESTEP

THE FOUNDRY of the Olympic Foundry Co., Seattle, Wash., which had been in operation only four weeks was almost completely wrecked by a landslide on the night of November 15, last year. The company immediately began the erection of a new plant which has just recently been completed and is in many respects more unique in design than the old foundry. The new plant is the most up-to-date establishment of its kind in the northwest.

The plant is located on the line of the Northern Pacific Railway at Argo, a manufacturing suburb of Seattle. The company owns three-and-a-half acres of land, part of which being on a steep side hill serves a very useful purpose that will be fully developed later. The cupolas have a capacity of twenty tons and the plant is designed to handle gray iron castings up to that weight. The company employs about 40 molders and as many more helpers and laborers when operating at full capacity. According to the common practice of the region the foundry uses Scotch pig which now costs about $29 a ton delivered; coke is obtained from the local coke plant at Wilkeson and is delivered at Seattle for $7.50 per ton.

Type of Construction.

The building is a slow burning frame structure 200 x 92 feet in size. It is painted. This fact is mentioned because altogether too many plants in this region have a "rustic" finish that is neither economical in the long run nor fit to be seen. The lighting of the building is good, another feature that differentiates this plant from many others in the region; about 60 per cent of the wall space is glass. The windows are 6 x 9 feet and inasmuch as they are kept clean artificial light is never necessary from sunrise to sunset. The interior of the building is painted white, which materially improves the lighting. For night work and evening work in the winter the molding floor is illuminated by five 1,500 candlepower arc lamps, assisted where necessary by the usual incandescent bulbs. Wall sockets are frequent, and portable incandescent lamps are used to assist the men in patching deep, dark molds; this system is a vast improvement over the old method of using mirrors and trying to reflect the sunlight around three corners and into the bottom of a deep mold.

Main Floor.

The main floor is of standard design and consists of a central bay and two side avenues each 30 feet wide, which extend the full length of the building. The molding is done in the middle bay and in the side avenue nearest the railroad; the other avenue, next to the hillside, is taken up with the tool and store room, the cleaning department, the cupolas and

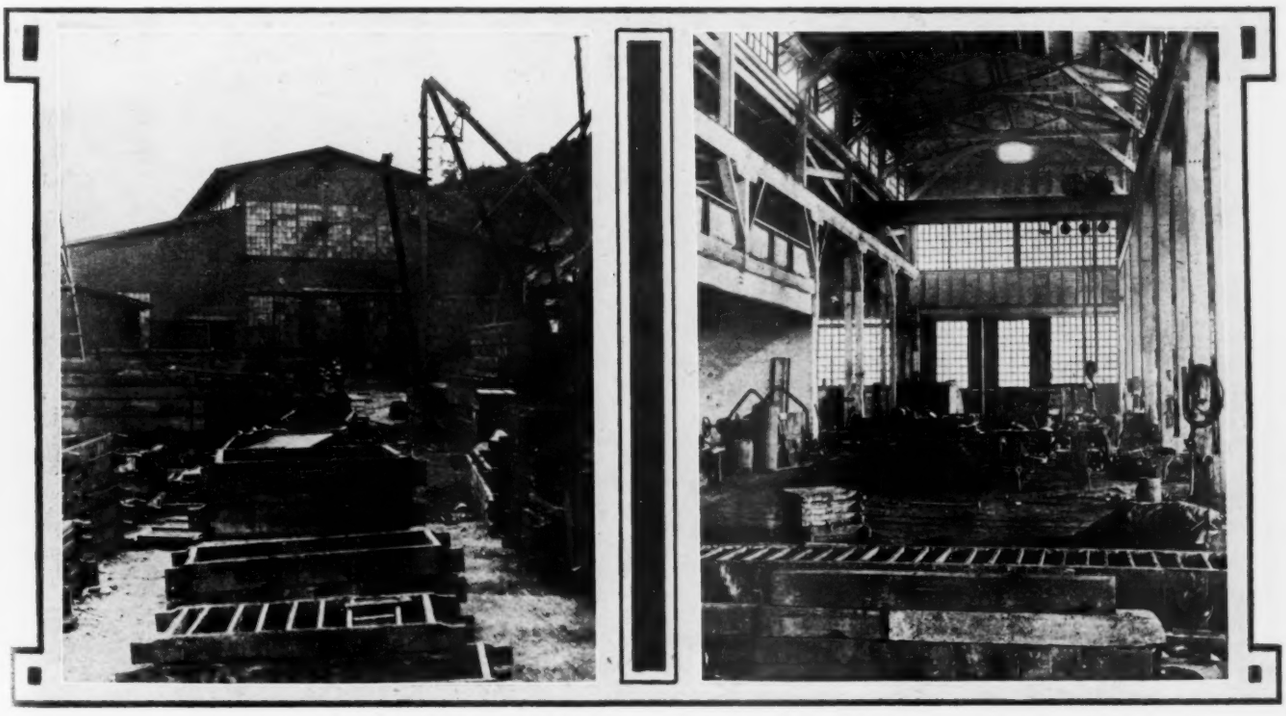


FIG. 1—OLYMPIC FOUNDRY

FLASK YARD

MAIN BAY

the core room. The molding floor area is 12,000 square feet. Compressed air is furnished to every point on the floor and is used to operate riddles, portable hoists, jacks and similar tools.

There are two cupolas, a 36-inch Colliau and a 32-inch Whiting, centrally located, unenclosed and of standard design. The blast pipes are brought from the fans located on the charging floor to the wind boxes of the cupolas with but two bends of less than 90 degrees; these connections are remarkably neat, simple and direct.

The core room, located in the southeast corner of the building, is 26 x 60 feet in size and is furnished with standard equipment, including a 12 x 18-foot oven served by a standard gage truck.

At the northeast corner of the building is a 26 x 35-foot room containing the tool racks and storage bins of flour, molasses, plumbago, gaggers, chaplets, etc. Adjacent to this room is the cleaning department furnished with the usual array of rattlers and similar devices.

Transportation Facilities.

The strong feature of this plant is the system of internal transportation. It is complete, simple, efficient and well worth copying. In this particular also the plant is strong where the average foundry is weak. The lower floor is furnished with a system of two-foot gage tramways consisting of two parallel tracks 30 feet apart running the full length of the building, connected by two cross tracks, shown in Fig. 2. One of these cross tracks leads between and behind the cupolas; the other curves into the core department. The longest of these tramways, running through the main bay, is situated directly in front of the cupolas and extends out into the yard at either end of the building. At its south end this track winds out through the flask yard. This yard is provided with a 50-foot boom derrick. Heavy flasks can be picked up by the derrick, loaded onto a truck and wheeled into the foundry by one man. This is a considerable improvement over the old method of sending six or eight men into the yard to carry the flask in on their shoulders. The north end of the track connects the foundry with the office and pattern shop situated 50 feet away.

In addition, the main bay of the molding floor is served by a 10-ton Whiting electric driven traveling crane with a 30-foot span and a 200-foot runway. The crane motors are controlled from the floor, thus dispensing with a motorman. Two jib cranes, one of 18-foot radius and 2,000 pounds' capacity at the south end, and one of 25-foot radius and 16,000 pounds' capacity at the north end of the room, completes the transportation system on the main floor.

Charging Floor.

Advantage is taken of the side hill in arranging the transportation facilities of the charging floor, which is 16 feet above the molding floor. A spur from the railroad is built along the hillside, parallel to the foundry, at the charging floor level. Cars of coke and iron are brought in on this spur. Between the spur and the building is a platform 180 feet long and 24 feet wide. Laid across this platform at right angles to the spur is a gridiron of 26 tram-tracks, making any point on the spur easy of access by a small car or buggy. The buggies are switched onto these gridiron tracks by means of a transfer track and truck similar to that used on a large scale in modern car shops. The charging floor is 26 x 60 feet in size and is furnished with one track extending from end to end down the middle of the floor, while two cross tracks lead to the charging doors. Scales are provided on the track between the cupolas. At one end of the outside platform is a 35 x 18 foot bin with a capacity of 75 tons of coke. The iron is stored between the tracks on the gridiron. The whole system slopes very gently from the railroad spur to the charging doors and the buggies loaded with coke and iron run down to the cupolas, crossing the scales on their way, without assistance. This comprises the most complete and original charging floor layout in the vicinity.

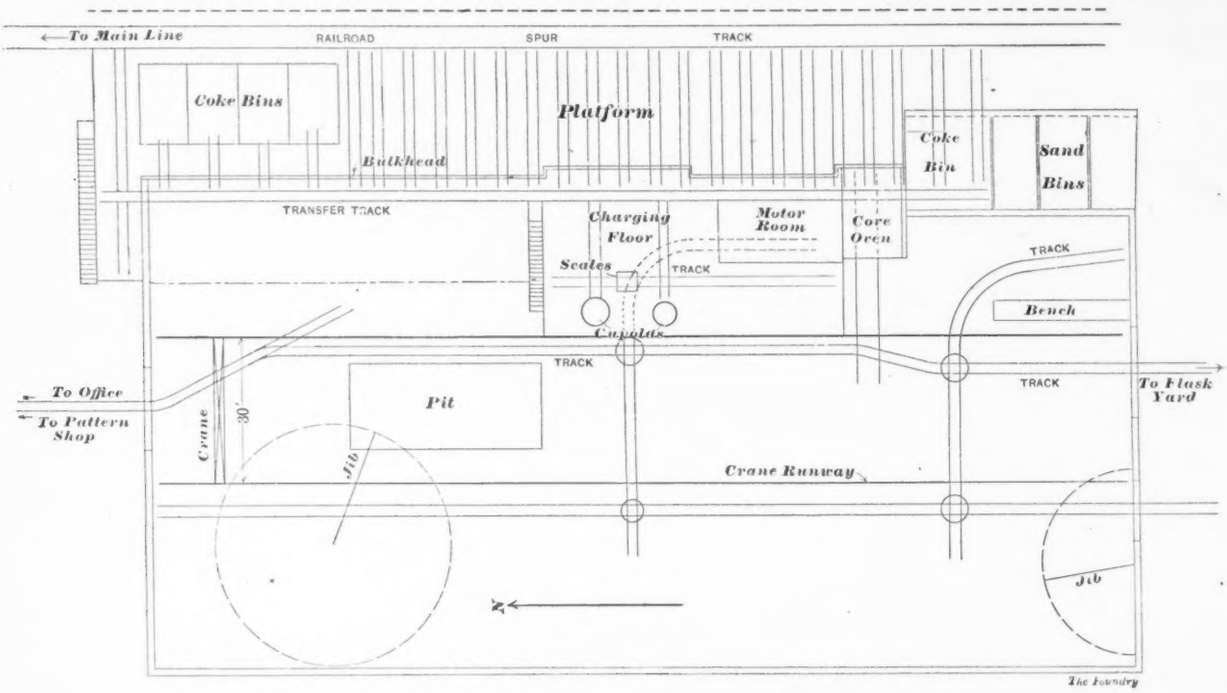


FIG. 2—PLAN OF THE PLANT OF THE OLYMPIC FOUNDRY CO., SEATTLE, WASH.

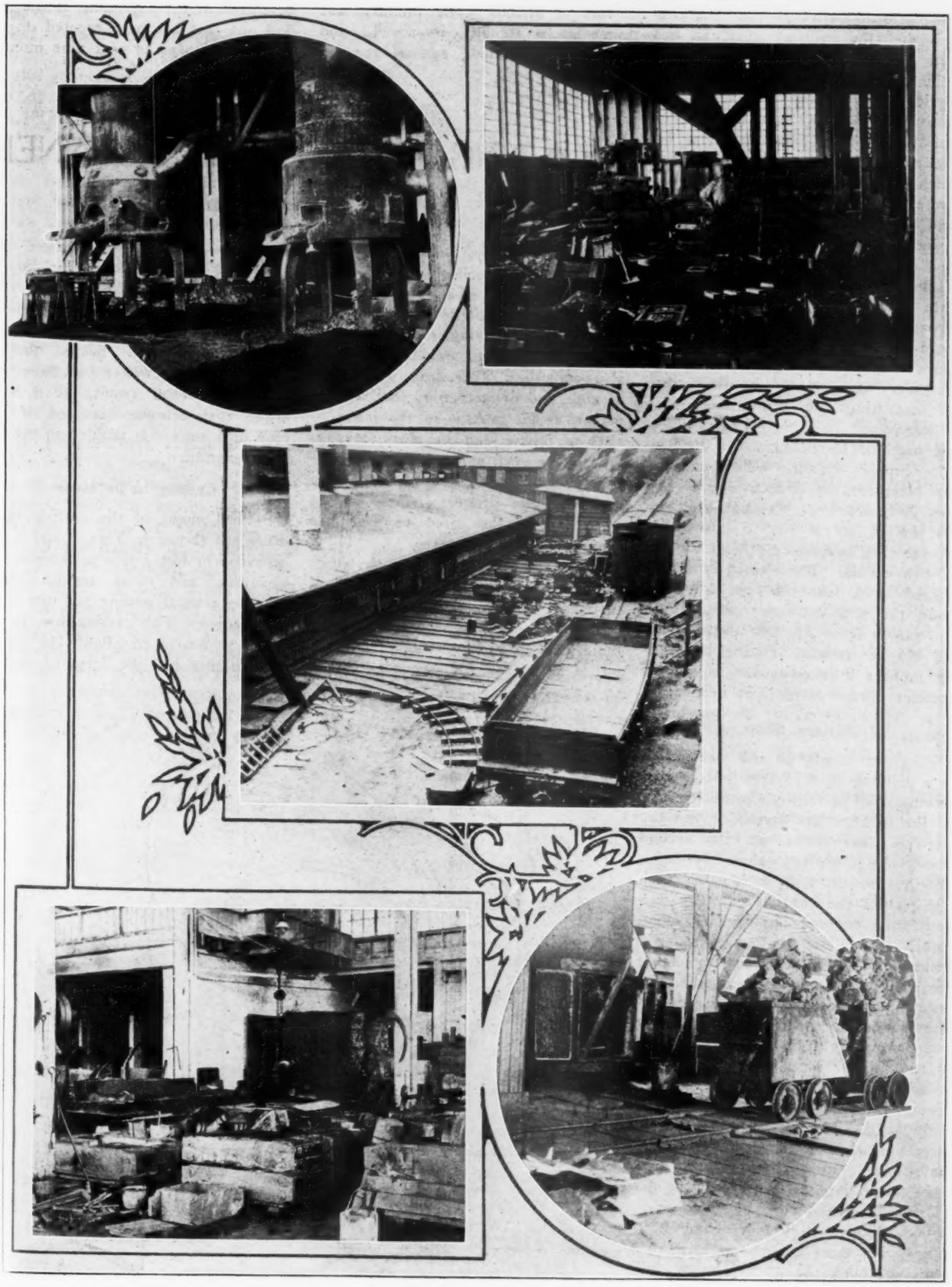


FIG. 3—OLYMPIC FOUNDRY

THE CUPOLAS

CORNER OF THE MOLDING FLOOR

LAYOUT OF TRAMWAYS BETWEEN RAILROAD SPUR AND CHARGING FLOOR

CORE OVEN

CHARGING FLOOR

The coke and iron are stored on the platform between the charging floor and the railroad spur, as has been indicated. The sand is stored in bins under this platform. Space is provided for three carloads, two chutes leading out over one of the tram-tracks in the molding room below convey the sand to buggies in which it is wheeled to various points where it is needed. Adjacent to the sand bins is a small coke pocket with a similar chute, which holds the coke used in the core ovens.

Like practically every plant in the state the machinery is motor driven throughout. The motors occupy a room 12 x 25 feet situated at the south end of the charging floor. The machinery consists of one small motor operating the compressor; one 35-horsepower, 60-cycle General Electric machine belted to a No. 10 Buffalo cupola blower, which supplies the blast for the 36-inch cupola, and one 20-horsepower Westinghouse motor belted to a No. 5 Sturtevant blower that supplies the blast for the 32-inch cupola. The electricity is purchased at a low rate per kilowatt-hour, the total average cost of light and power from April to October being $75 per month. During the winter months it is somewhat higher on account of the extra light needed.

Pattern Shop.

Fifty feet north of the main plant is a building 50 x 75 feet in size containing the pattern shop and offices of the firm on the first floor and the pattern store room on the second floor. The pattern shop is light, roomy, modern and in keeping with the rest of the installation. The pattern store room, being on the second floor, is dry, and is kept at a fairly even temperature, two conditions that materially assist in keeping the patterns in good shape. Heavy patterns are lowered to the tramway below by means of a light jib crane.

The firm was incorporated in Washington in 1900 as the Olympic Foundry Co.; the capitalization is only $20,000 and by no means measures the value of the plant. The company soon outgrew its original quarters and a new modern plant was designed and completed by October 1, 1906. The new foundry had been operating about four weeks when on November 15 the adjacent hill, loosened by heavy rains, slid on the plant in the night and practically ruined it. A temporary furnace was procured, erected, and ten days after the accident the plant was again operating, but with a very much diminished output. The accident entailed a loss of $16,000. The foundry was immediately rebuilt, improved, and provision was made against the recurrence of the disaster. The plant described in the foregoing is the second one that has been erected on the premises within the past nine months.

MOLDING A CAST STEEL RUNNER

BY H. J. McCASLIN

ALTHOUGH the method of molding a cast steel runner for a centrifugal dredge is not of an intricate nature, it nevertheless affords a very good example of revolving sweep work as applied in forming circular molds. It also embodies other features worthy of note, and of interest to the pattern-maker, as his portion of the job consists of laying out the work, arranging the sweeps, constructing the necessary core boxes, and he must also supervise the proper placing of the cores within the mold to give the required metal thickness.

There are several methods by which a steel runner casting, as herewith illustrated, can be molded. The one frequently employed is that of a core mold, that is, the entire mold is made up of a number of dry sand cores, and these cores are so arranged on a level bed that they form an impression of the runner to be cast. While a core mold is often advantageous in the production of circular pieces, particularly of a spider design, the experience of the writer has been that safer and better results at a much lower cost can be obtained, if this type of a runner is molded in the following manner.

Casting to be Made.

Several views of the casting to be made are shown in Figs. 1 and 2. Illustrated in Fig. 1 is a plan view, side elevation, and cross section, showing the general outline and the metal distribution. The casting has an average thickness of about 1¼ inches. The casting has the form of two ir-

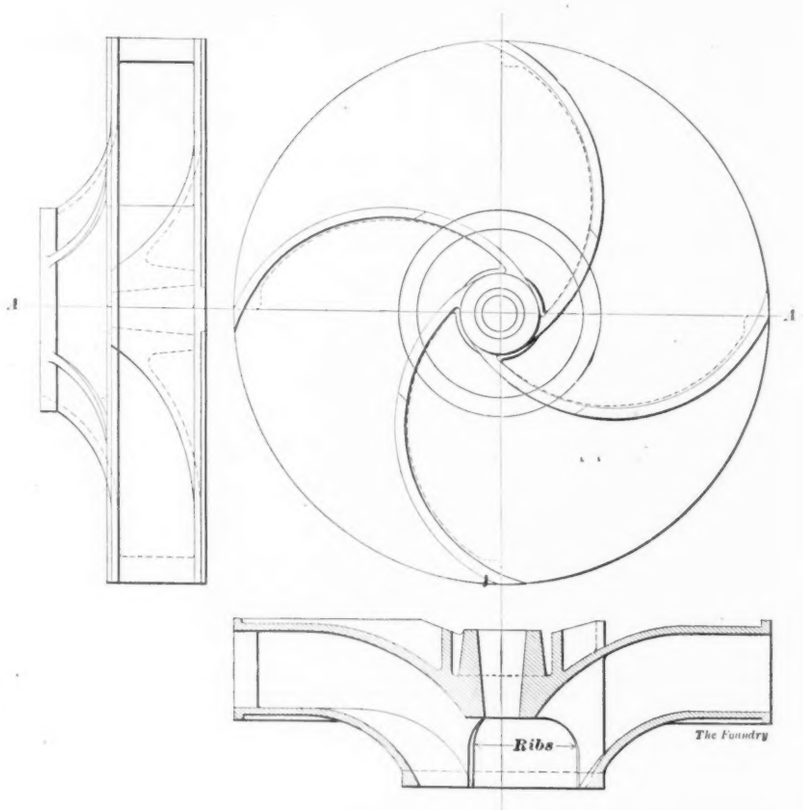


FIG. 1—PLAN VIEW, SIDE ELEVATION AND CROSS-SECTION OF CAST STEEL RUNNER

regular discs or circular walls, connected by partitions or ribs, these ribs forming four equal veins or openings through which the material is discharged. Fig. 2 is an inverted plan of the runner, showing the intersection of the four ribs with the internal hub. This portion of the work should receive careful study, as it is upon the lines of the ribs that the four cores forming the interior of the runner meet, or butt together, as shown at G, Fig. 8. By referring to the cross section AA, Fig. 1, it will be seen that the four ribs are cut back to increase the area at this point. A cross-section of the completed mold is shown in Fig. 3. It consists of a swept up drag, four vein cores, bore core, cope and runner and riser.

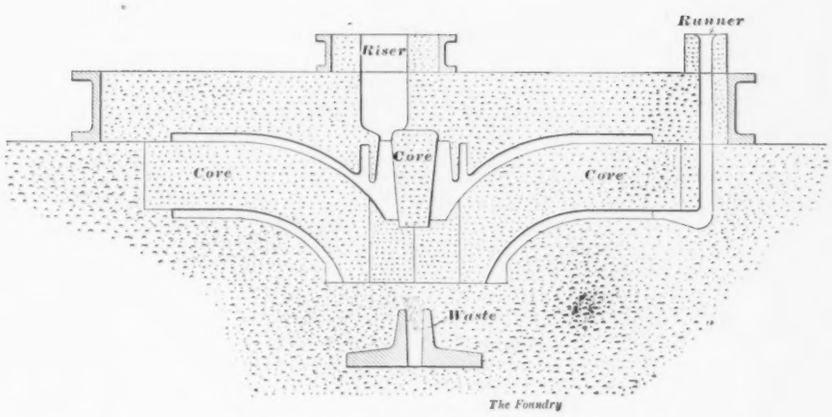


FIG. 3—CROSS-SECTION OF COMPLETED MOLD

Sweeps.

The patternmaker begins his part of the work by laying out a full size plan of the veins, which is essential in the construction of the core box. A radial section, as shown to the right of the center line, Fig. 1, is also required in getting out the two sweeps shown in Figs. 4 and 5, also the ribs and hub, shown in Fig. 6. As the striking edge of the sweeps alone are required, their construction is of no importance. They may be cleated together, their striking edge containing a radial section of the exterior form of the runner, or that portion of the mold they are intended to form while being revolved about the spindle.

Cope.

Fig. 4 shows two half sections of the cope portion of the mold in two stages of completion. This part of the work consists of striking up a bed conforming to the outline of the side of the runner previously referred to. It is upon this surface that the cope is placed, rammed up and lifted off in the usual way. With the socket and spindle firmly set and plumbed, sweep B is attached, and a bed conforming to its striking edge swept up. By the aid of the trammels the bed is divided into four equal parts. By using that side of the sweep which lies in the plane of the axis of the spindle, right angle lines are scribed across the flat portion of the surface upon which the cope is to rest. These lines correspond to the lines E-E, Fig. 8, and are not only used for locating the cope on the drag portion of the mold, but also for placing and bedding in the ribs D, shown in Fig. 6. Hub C, as shown in detail Fig. 6, is provided with a hole at its center to fit the spindle and is placed in position as shown to the left of the spindle, Fig. 4. Guided by the hub and the right angle lines as scribed upon the bed, the four ribs D are set and secured in position by spikes driven into the bed at the sides of the ribs with their heads projecting about three-eighths of an inch.

The spindle is then removed, and the swept up surface, with the hub and ribs in place are given a good application of parting sand. The cope is next placed in position as shown to the left of the spindle, Fig. 4. Silica sand, to a depth of about one inch, is next applied to the swept surface, being tucked about the ribs, hub and runner, and the flask is then firmly rammed or backed in with heap sand. As the hub contains the heaviest portion of metal, the riser, which is about 12 inches in diameter, is placed over this section. Before lifting off the cope, the right angle lines, as scribed across the bed, are carefully transferred to the edge of the lower flange of the flask and marked with a defining line. With the cope lifted off, suspended or blocked up, the ribs and hub are withdrawn, and this part of the mold receives the usual slicking and nailing up, followed by an application of silica wash. If too large to be introduced into the oven, a coke or gas fire is enclosed beneath it and it is thoroughly dried.

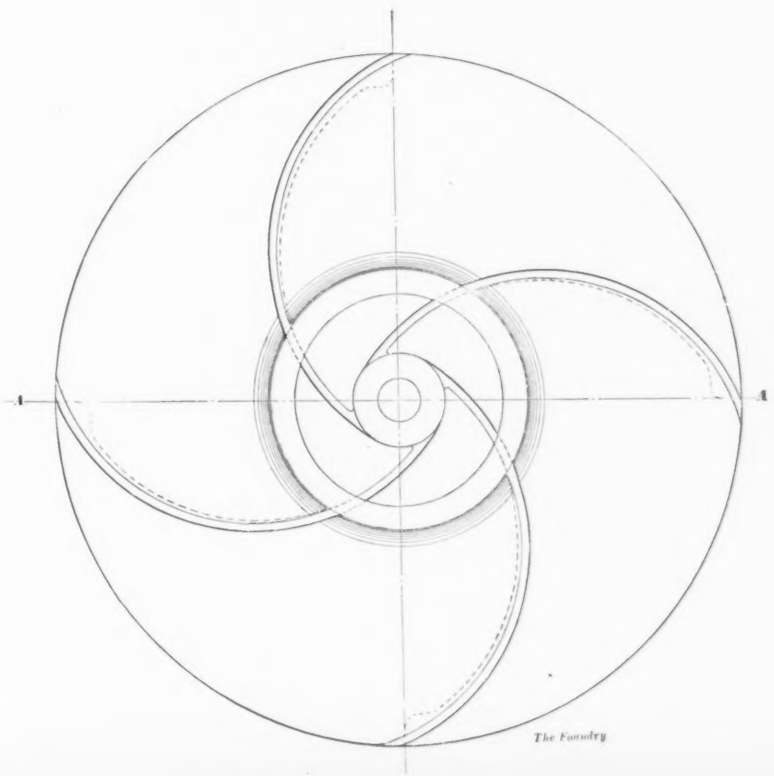
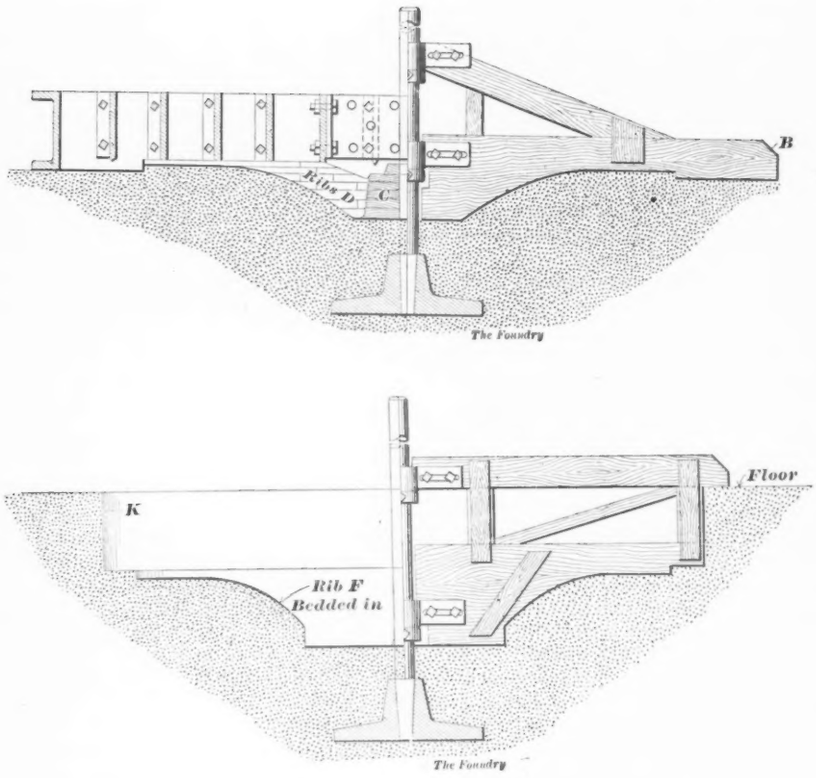


FIG. 2—INVERTED PLAN OF RUNNER



FIGS. 4 AND 5—TWO SWEEPS USED FOR MAKING THE MOLD

Sweeping the Drag.

Shown in Fig. 5 are two radial sections of the drag portion of the mold during the operation of sweeping, and also at its completion, with the sweep removed and ribs F bedded in. Work on this part of the mold begins with the digging of a hole in the floor, of a diameter somewhat larger than required for the revolving of the sweep, and the placing in position of the spindle. The sweep having been adjusted to the height of the floor line as shown, heap sand is firmly rammed in to conform somewhat to the outline of the sweep, and about one inch back from it. This space is provided for a thickness of silica sand which is applied and firmly rammed down and struck off to conform to the outline of the sweep. As the outer diameter or perpendicular surface K, meets the dry sand cores, no silica is applied to this surface. The right angle lines as shown in Fig. 8 are now spaced off, being transferred down into the mold by aid of the sweep, as previously described. With the mold thus spaced off it becomes a simple operation to locate and bed in at their correct location the four ribs F, one of these ribs being shown in detail, Fig. 6. The mold is then given a good application of silica wash and thoroughly dried by a coke or gas fire.

Setting the Cores.

While Fig. 7 shows one of the four cores which form the interior of the runner, suspended, and in position for setting into the mold, Fig. 8 gives a plan view of the mold with two of the cores in place. Proceeding with this part of the work, the mold is thoroughly cleaned or blown out with air. Guided by the lines E E, the first core is placed in position. It will be readily seen that if the first core is set correctly and if the four cores are true to size, their correct setting is assured. If they become distorted in drying, a little filing or rubbing may be necessary. The bore core is next set in position. To ascertain if the metal thickness is correct, clay balls are placed at several points upon cores and the cope carefully tried on. If found to be correct, the cope is returned to place and weighted down and the mold is poured.

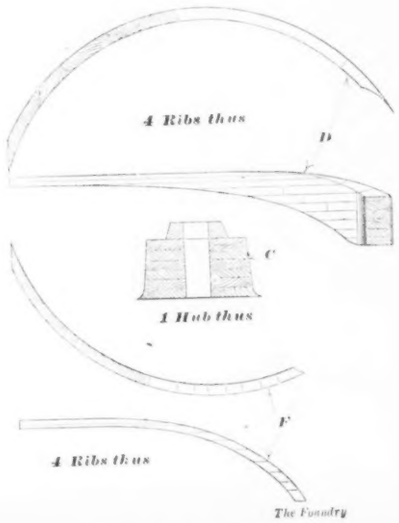


FIG. 6—RIBS AND HUB

Core Box.

Fig. 9 illustrates one method of building up by segment work the core box employed in forming the four cores. Owing to the irregular form and size of the cores, the box must be of rigid construction to prevent, as far as possible, the distortion of the cores during the rolling over of the box. To permit and facilitate the removal of the box from the core, it is provided with three suitable joints L, these joints being secured together with screws, or bolts. The three side sections of the box having been built up to the required height, they are dressed off to form and fitted together. If care is exercised in sawing out and gluing up this segment work strictly to the line, very little work will be required in dressing it to a surface. As two of the side sections are cut away, as shown at M, to conform to the outline of the strike, shown at the right, Fig. 9, it is not necessary and only a waste of material to build them to the full height throughout.

With the sides built up, dressed off and secured together, the strike O, which conforms to the interior outline of the runner and is provided with a

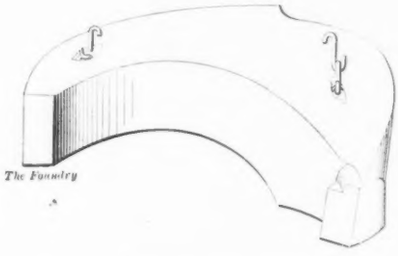


FIG. 7—ONE OF THE FOUR CORES

center pin J, is placed in position as shown in the dotted lines. By revolving the strike about this center, the sides of the core box at M can be dressed off to conform to the outline of the strike. With the building up and working off of the bottom board, somewhat after the manner

hown in the cross section of the oard, Fig. 9, and which is dropped nside of the core box, the work is ompleted with the usual application f shellac.

Making the Core.

The core box having been placed upon a level surface or plate, the bottom board M is let down in place, and the ramming and rodding of the core is in order. For handling and rolling over the core when dried, suitable hooks are secured into the rodding from each side of the core. When the ramming and rodding has reached the top of the box, strike O is attached and the top of the core struck off to its outline.

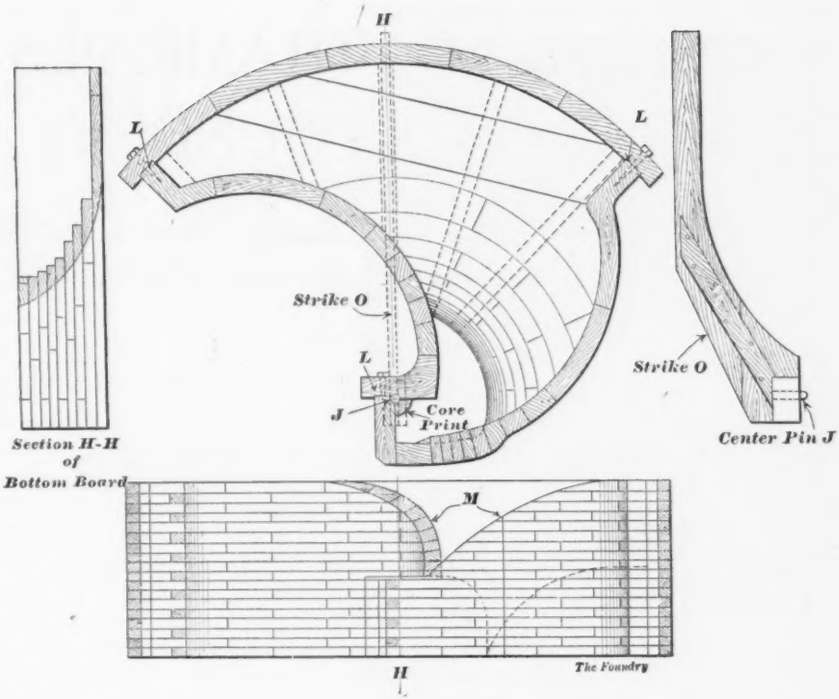


FIG. 9—METHOD OF BUILDING UP THE CORE BOX

PRODUCTION OF ALUMINUM IN 1906.

The production of aluminum in the United States in 1906 reached the enormous total of 14,910,000 pounds, or almost double the output of 1903. The production of this metal for commercial use, which was undertaken in 1883, grew very rapidly until 1897. During the next six years the output was maintained at a high figure, but with no important gain from year to year. Since 1903, however, there has been a rapid increase owing to the extensive use of aluminum in automobile manufacture. Most of the automobile builders are now using bodies made from aluminum and the consumption for this purpose within the last few years has reached a very high figure. The aluminum manufacturing industry is shown quinquennially in the following table:

	Pounds.
1885	283
1890	61,281
1895	920,000
1900	7,150,000
1905	11,347,000
1906	14,910,000

Growth of Industry.

The growth of the aluminum industry has been concurrent with the development of the Pittsburg Reduction Co., Pittsburg, the name of which has recently been changed to the Aluminum Co. of America. Operating under the patents of Charles M. Hall, vice president of this concern, the establishment and development of the aluminum industry has resulted in a greatly reduced cost to consumers, for prior to Mr. Hall's invention in 1886, the price of imported aluminum in American markets was about $15 per pound. The production of bauxite, the ore from which aluminum is extracted, reached a total of 75,332 gross tons in 1906. As compared with the previous year, the output increased nearly 57 per cent, as the production in 1905 was only 48,129 tons. The principal deposits of this ore in the United States have been found in Arkansas, Georgia and Alabama, and during the past year bauxite was discovered in Tennessee, Virginia and Pennsylvania.

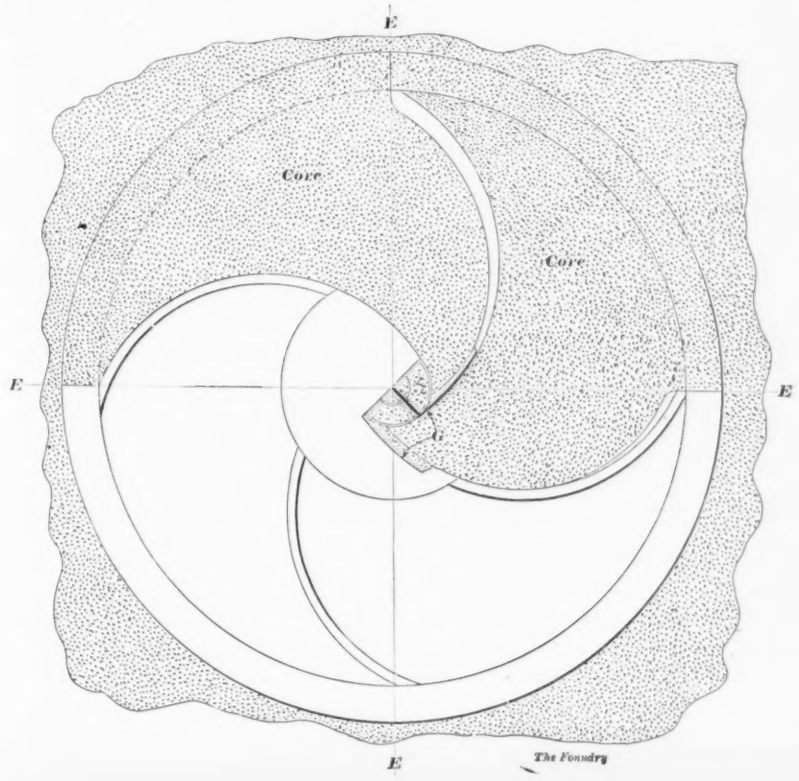


FIG. 8—PLAN VIEW OF THE MOLD WITH TWO CORES IN POSITION

OVERHEAD TRAMRAILS FOR THE FOUNDRY

System of Delivering Metal to the Molding Floors—Handling Cores—Cleaning Room Service

BY A. W. MOYER

FEW labor saving devices have been introduced into American foundries in recent years that can compare with the overhead tramrail as a cost reducing factor. Briefly described this system consists of an overhead rail hung from the roof trusses by means of hangers so suspended that a load of hot metal, pig iron, sand, cores, flasks or finished castings may be run along on a trolley. The trolley has anti-friction bearings and wheels, and operates so easily, that a load of 1,500 to 2,000 pounds can be moved by one man with less exertion than is required to carry a fifty pound load by hand. The use of switches and turnouts permits the load to be moved to any desired part of the foundry.

Conveying Molten Metal.

As generally installed, the rail extends through the pig iron storage yard. The metal is loaded on a cage and runs along the rail to a lift having a section or tramrail on it and is elevated to the charging floor where it is either stored or charged direct into the cupola. One man carries the ton-load and handles it easily.

The rail is looped around the front of the cupola and has branches over the different molding floors, and when the heat is poured, ladles of from one to 2,000 pounds capacity are conveyed by one man direct to the molders. This has the effect of greatly increasing the efficiency of the cupola. The iron is also delivered to the molder at a higher temperature than when carried by hand in small ladles. Many castings, by reason of the amount of metal in them, require three or four to pour each mold. In the production of water pipe, many molds are lost because the metal in the hand ladles is not uniform in temperature when poured. When pipe molds are poured from a tramrail, the ladles have four lips, and the whole pipe poured with metal of a uniform temperature.

An illustration of making the bull ladles suspended from the tramrail practically serve as small cupolas, is shown in Fig. 5. Here 2,000 pounds of metal is run to the floor and poured into the hand ladles. Instead of the molders gathering at the cupola with their hand ladles, awaiting their turn, and then carrying 50 or 60 pounds of metal to their floors, no matter how far distant, the metal is brought to the molders and considerable time is saved. The danger of accidents is obviated, and the molder is physically better able to do the work for which he is employed.

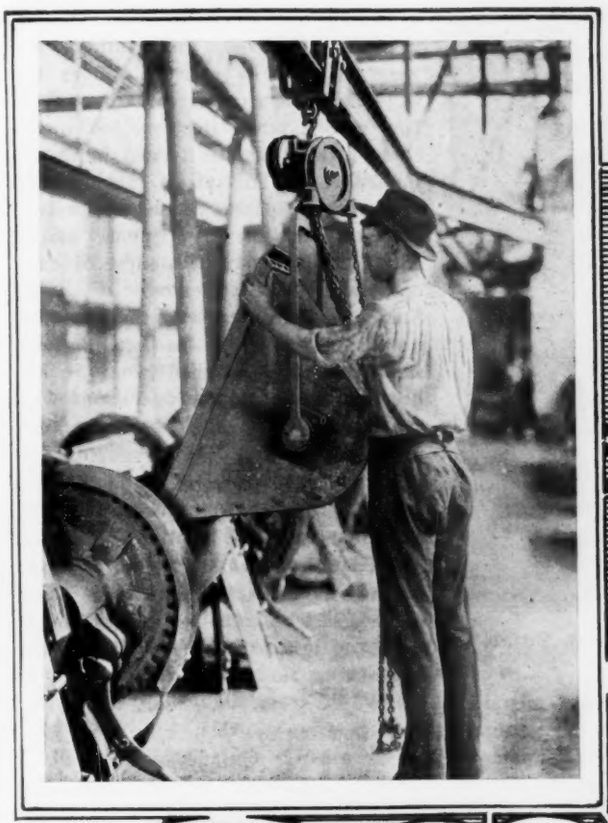
Cleaning Room Service.

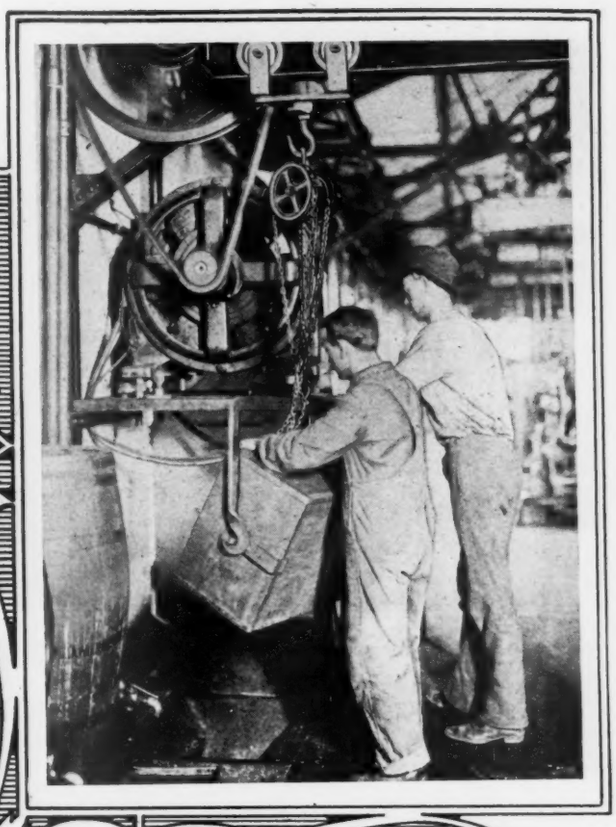
When shaking out, the castings are carried by tramrail to the rumblers, Fig. 1. A ton can be easily handled by one man, thus effecting a decided saving in labor. After the castings have been rumbled, they must be ground, and by means of a rack, Fig. 2, the grinders are served. From the grinding room, in the case of pipe fittings, they are carried on the rail in buckets or boxes to the tapping machines where the threads are cut. The oil must be removed from the fittings if they are to be galvanized, and dumping boxes on a trolley are hung over the open top of the pickle tank, Fig. 3, from which the castings are dumped into the pickle. After the oil is removed, the liquid is drawn, the gate in the tank is opened and the castings are dumped into another bucket suspended on rail on the floor below which extends into the galvanizing room. A comparison of this method of handling pipe fittings with the old method of handling by hand, floor truck, wheelbarrow or industrial track indicates the tremendous saving in the labor that can be effected.

A tramrail extends from the rumblers to the ovens, through them and out over the hot wells. Here the pipe is lowered on the trolley into the well by means of an electric or air hoist, raised again, and then run over a drip pan, which carries the drip back into the hot well. From this point, still on the rail, the dipped castings are conveyed to the stock bins, if they are to be stored, or to the loading platform, if they are to be shipped. The stock bins may be easily filled and emptied for shipment, as shown in Fig. 4. A branch rail extends through each passageway between the stock bins, and a box containing the castings, or a bucket, can be suspended from the trolley and the contents dumped into any of the bins. This system permits of a closer arrangement of bins, less floor space is required, and whether the floor is clear or littered, the box carried on the tramrail easily clears all obstacles.

Handling Cores.

The greatest saving of time and expense effected by the tramrail in the foundry is in the handling of cores. Fig. 6 shows the racks in front of the core ovens. The green cores are carried by hand and placed directly on racks which are made of steel pipe or angles. These racks are hung on a trolley, and when filled run directly into the ovens while still on the rail. After baking, the rack full of cores is run over the tramrail system direct to the floors and then distributed. By this arrangement the cores are never rehandled from the core maker to the molder. Less cores are broken, and usually a man or a boy can distribute enough cores for 100 molders. If this system is compared with the old method of carrying by hand with the attendant danger of dropping a load, or by wheelbarrow with the danger of overturning or running into some obstacle jamming the cores together and crumbling their sharp edges, a distinct advantage of handling the cores by tramrail will be noted.





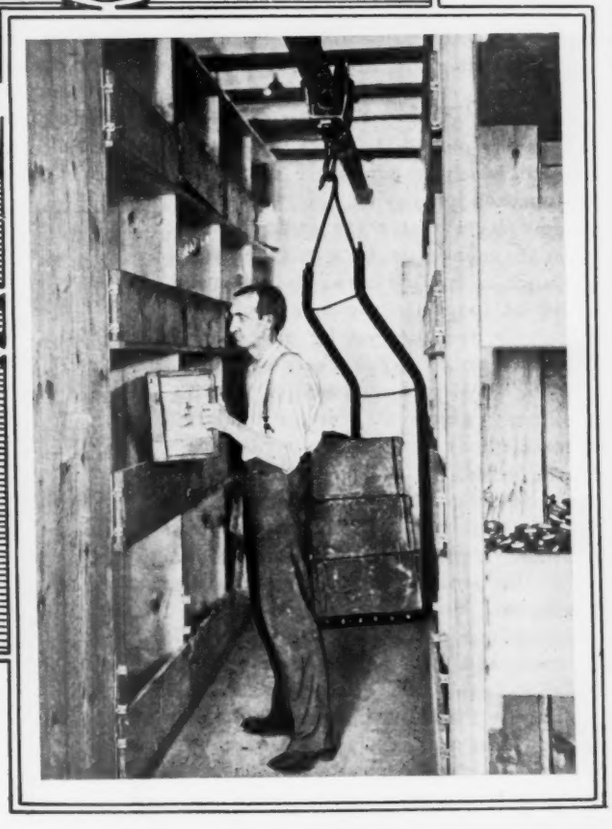


FIG. 1—DELIVERING CASTINGS TO THE RUMBLERS
FIG. 2—RACK USED FOR CONVEYING CASTINGS TO GRINDING ROOM

FIG. 3—TROLLEY USED FOR DROPPING CASTINGS INTO THE PICKLING VAT
FIG. 4—STOCK BINS SERVED BY OVERHEAD TROLLEY

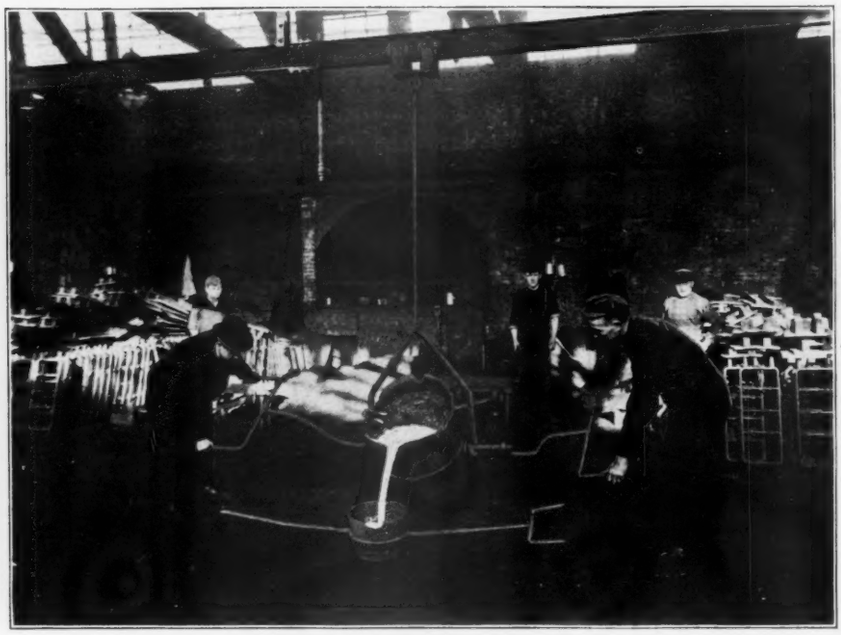


FIG. 5—SUSPENDED BULL LADLE FROM WHICH HAND LADLES ARE FILLED

A saving of labor can also be effected by extending a spur of the rail to the sand bins. With a dump bucket and one man 1,000 pounds of sand may be brought in at a time and distributed to the different floors. When it is considered that the sand is usually carried by a wheelbarrow, 300 pounds to the load, it will be seen that three times the same load is carried with less labor by the overhead rail.

Overhead Scales.

Probably one of the most important uses to which tramrails are put is in the method of paying the workman. It may seem that there could be no possible connection between the two, but such is not the case. In the majority of foundries the men are paid either by the day or by the piece. They are either day workers or piece workers. We will not consider any of the many arguments for or against these methods, but will refer to some of the defects of the piece work plan of payment. Every foundryman is familiar with the many disputes that constantly arise between the man who does the work and the man who counts it. Much time is lost by recounting—the workman's time which he loses, and the counter's time which the firm pays for. Foundrymen are well aware that a recount, even though it shows the workman's count to have been correct, does not eliminate the thought from his mind that the "counter" is working in the interest of the firm, and consequently against the man who turns out the work. Discussions arise, and often a good workman is disgruntled. These mistakes, discussions and disputes are entirely eliminated if the workman is paid by weight. With the exception of the molder, every foundry employe can be paid at the pound rate. Nearly all of the finished product is sold at a pound price, and it would be of great benefit to the cost department to know what the rumbling cost, grinding and other finishing operations are per pound.

This result can be readily obtained by means of a tramrail system, which has installed at certain points a tramrail scale. Let us assume that in the rumbling and grinding room a scale is placed, and when these two operations are finished, the castings are weighed, and the man who does the work is given a ticket with the weight and rate entered thereon. A duplicate of this ticket is turned in to the timekeeper who, after making the proper entry passes it on to the cost keeper. The scales conveniently placed will record the exact weight of each operation. The scales are of United States standard test and there can be no dispute with the workman, as he sees his work weighed when it has been finished. All the operations with the exception of molding are handled in the same way.

If the scales are properly placed and are operated in connection with the cost department or by the timekeeper, the counters formerly employed are entirely unnecessary. In a large plant, the wages paid to counters is considerable, and instances can be cited where this saving alone has paid the cost of the whole tramrail system each year. The scales, as shown in Fig. 8, are simple in construction and can be had in varying capacities. The scales are attached to a section of the rail which is so arranged that the load is weighed as it passes along. The necessity of lifting the load off the rail and onto a floor scale is entirely obviated. The majority of floor scales with the working parts sunk in pits are unfit for foundry use as sand and dirt soon works down into the operating plate. The knife edges are not only cut out by the sand in a short time, but the

FIG. 6—RACKS FOR HANDLING CORES

dirt fills up the pit and prevents proper operation of the scale.

Tramrail Installation.

Any tramrail system will save its initial cost each year, but a number of points should be considered before the system is installed. The rail should be of such section that the foundry dust will not settle on it and clog the progress of the trolley. The rail should be heavy enough for the greatest possible load handled in the plant. Sufficient switches and turnouts should be provided, that two loads going in opposite directions on the same rail may pass. The arrangement of the rails in front of the cupola should be such that an empty bull ladle can be suspended next to the ladle being filled to catch the metal as it comes from the spout without undue waste.

Too much attention can not be given to the proper layout of the rails and switches in front of the cupola. Whether the heat be large or small, as the iron comes from the spout in a continuous stream, the ladles should be under the spout to receive it. Fig. 7 shows an excellent arrangement. A tilting spout on a pivot is used, and while one bull is being filled, another is in position to receive the metal. By means of a loop of rails and switches, the filled ladles are constantly coming from the cupola during the heat and the dead ladles travel toward the spout, and neither time nor metal is lost.

The trolleys and curves should be arranged so that no more effort is required to push the loads around the curves than on the straight section of track. The wheels should revolve in anti-friction bearings that one man can move a load of 2,000 pounds if necessary.

FIG. 7—TRAMRAIL LAYOUT IN FRONT OF THE CUPOLAS

Switches.

The switches should be so constructed that they cannot be turned except when operated by levers provided for this purpose. They should be automatically locked at all times, and the open end of the rails should be provided with automatic stops to prevent the load from falling from the ends of the rail. The switches, in a word should be "fool-proof."

To sum up the whole subject, let us consider that one man with a wheelbarrow can handle 300 pounds; with a floor truck over a wooden or cement floor 1,000 pounds; over a foundry floor 500 pounds; with an industrial track in a foundry when the tracks are in their usual condition, 1,000 pounds. With an overhead tramrail, one man can always push a load of 2,000 pounds. Therefore one man and a tramrail system equals nearly seven men with wheelbarrows; four men with floor trucks, and two men with an industrial track. Computed in men-loads, the assertion made that the tramrail system will return its first cost each year can be readily computed in dollars and cents.

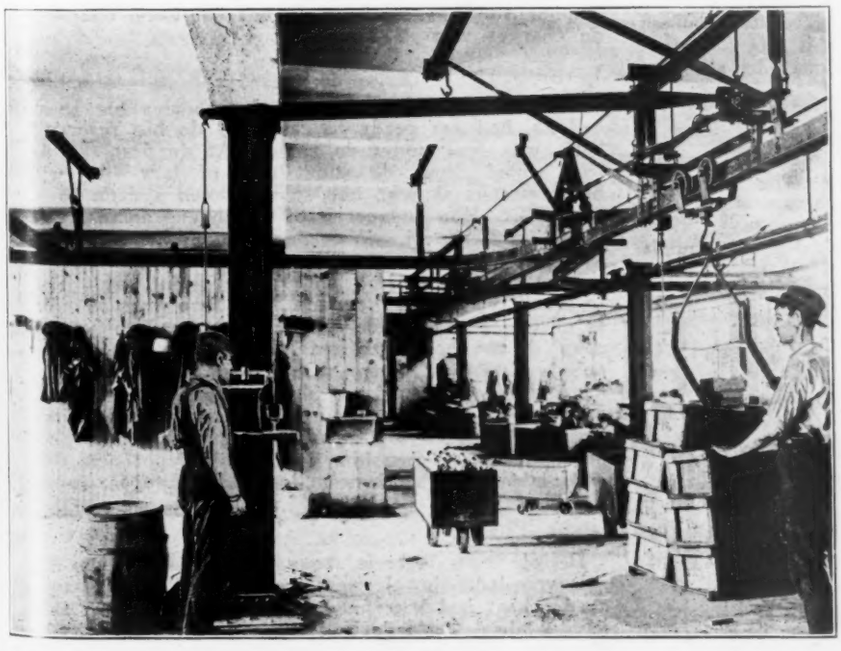


FIG. 8—SCALE ON OVERHEAD TRACK FOR WEIGHING MATERIAL AS IT IS CONVEYED FROM ONE DEPARTMENT TO ANOTHER

BELL CASTINGS.

Question:—What kind of iron is used in the production of cast iron bells and what is the analysis of the castings?

Answer:—The approximate analysis of the bell castings made by one of the largest foundries in the country making a specialty of this class of work, follows: Silicon, 0.60 per cent; sulphur, 0.04 per cent; phosphorus. 0.15 per cent; manganese, 0.30 per cent; total carbon, 4.50 per cent. A mixture successfully used contained southern white iron, 2,300 pounds; gates, 150 pounds; spring steel, 100 pounds; horseshoe scrap, 100 pounds.

Experience of Mr. Knowit, The Expert Melter

SAY Bill, did you hear bout de finish of de wise gazabo down to de shop? Well say! De gran' finale was suttinly one of de mos' spectacler ever pulled off on de pig iron circuit. De synopsis of de play reads sort o' punk in de openin' lines, but de situations on toward de climax wuz sure funny. You see de ole man wuz down 't the big city and wuz doin' de "White Way" one night along wid some engineer friend. Dey was speelin' about metallurgy an' de needed advancement in de foundry industry, an' here is where Mr. Wise Gazabo from Pawtucket butts in. Yu see he was settin' at a table near enuf so's by elongatin' his neck to de elastic limit he had been able to get wise to de talk goin' on over de ole man's private wire. How de ole man ever stud for his pluggin' his line is more dan I kin conceive, but must a bin de overmasterin' individuality of de Mr. Knowit.

* * *

Anyhow, he jus' faded de both of dem wit his knowledge of how tings ought to be done an' how little de men in charge of cupolas an furnaces knowed about meltin'. His ways and means wuz so far ahead of de times dat mos' men refused to credit him, but he cud show de foundrymen of de world how to melt iron widout fuel, almost. An' so he wuz signed up wid our stock company as leadin' man to play de heroic parts, an' at an "advanced vodeveel" salary, too. He didn't wait long for to reherse wid us, but took de center of de stage at onct. De fust mornin' he tells Tim, de cupola man, dat "he needent mind patchin' de linin' much—jis swab her over wit a clay wash a bit an' trow up de doors an' ram in de bottom. Den he would show him how to make de brest." Tim was a bit groggy frum de body blow, but he never batted a lash. He wuz too wise. He jus done as he wuz tole. When de bottom wuz in, de wise man, he makes a brest, rammin' it tight outen clay wid a bit of sand mixed in, an' about a ¾ inch hole trough it like a section of a numatic tube about 8 inches long, dis all bein' done before de bed wuz put in.

* * *

He den tells Tim to cut de bed coke 400 pounds, as he says, "Ye use too much coke." Tim wuz stannin' up under de punishment like a toroubred, but almos' took de count when de wise one says, "Now put 14,000 pounds on de bed charge, den 300 pounds

Takes a header under de spout

Mr. Knowit Butts in

coke an' 10,000 pounds on de nex two, den 250 pounds coke an' 8,000 pounds on de las' charge." Yu see de heat wuz 42,000 pounds in de ole 72-inch shell lined up to 60 inches. Tim recovered his wind and follows de directions. When de blast wuz put on, de first bit of iron to come down fills up de numatic tube trough de brest and freezes like it wuz struck by a stepmudder's breth. Den when cum time to tap de fun begins. Tim butted away with his tappin' bar fur awhile, wid Mr. Knowit lookin' on an' smilin'. Den Tim picks up a hammer an' a short bar an' bumps her sum more, while in de meantime de wind wuz not shut off an' de iron wuz gettin' into de wind box trou de tuyeres. Mr. Wise has lost his smile. He says sumpin' bad an' grabs up a sledge an' starts for de cupola, but ketches his toe under de shank of a ladle and takes a header under de spout. He wuz picked up, an' say! if de iron absorbed de sulphur frum his language I bet you it wuz too hard to machine. Well, he directs Tim an' a big husky to knock a hole in her an' dey does all rite, all rite. An' as dere wuz only a small ladle under de spout all de iron in de bosh run over de floor, matted up a lot of crane chanes and filled up de switch of de shop track, etcetery.

* * *

Well, by de time dis wuz fixed up, de brest patched an' so forth, de heat was queered like it had a curse on it, an' de bottom wuz dropped widout pourin' a mold. Dat night a gang cleaned up de ruins an' de next day Tim an' de wise gazabo goes at her again. Dis time Tim watches de guy an' makes de brest hisself durin' an intermission, so as to avoid de sulphur smell arisin' frum de hot language, oderwise de charges wuz de same.

* * *

McDougal an' his gang had closed up a big shear bed an' had her ready to cast. So de big reservoir ladle wuz first under de spout. At de first tap de iron rolled down de spout sort of lazy like wid black streaks showin' like stripes down a cat's back. Say, Bill! You cud cut it off in chunks an' carry it away on a shovel. Wen de reservoir wuz full an' set in place to pour an' de 10-ton ladle wuz full, it was started in de left han' runner. But say! Dat reservoir wudn't run a drop. De iron wuz as cold as de coffee over to de boardin' house an' de bottom roun' de tap hole wuz froze. De 10-ton wuz empty an' de heads an' risers wuz blowin' off to beat de band. De wise guy wuz dancin' roun' an' shoutin'. Say! You seen de pictures of Lulu's papa when Leander steps on his corns? Well, dat wuz de new boss all rite. I seen him goin' to de depot nex' day wid his grip an' a downcast look. Back to de woods for him.

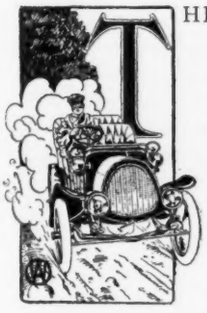
* * *

De ole man is tryin' to sell dat chunk frum de reservoir ladle, but I guess dynamite will fix it same as de shear bed wuz fixed. We wuz shut down two days while dey got de iron outen de wind box an' de ole man sent for Jim to cum back an' take his ole job bossin'. Well, so long, Bill, dere goes de whistle an' I got to hike.

BEARING CASTINGS FOR AUTOMOBILES

Patented and Secret Combinations of Alloys Introduced to Meet the Requirements of the Automobile Industry

BY E. F. LAKE



THE designers and experimenters in the automobile business have searched the field of metallurgy, waded through all the text books and formed all kinds of combinations out of the known metals to produce something better for bearings than those formerly in use. This is due principally to the fact that the automobile demands a light weight and high-powered generating plant and the results obtained along this line are marvellous. If any engineer had prophesied ten years ago that a machine would be built that would propel itself over rough roads at a mile a minute with a total weight of 2,250 pounds, and develop a horsepower of 250 with a power plant weighing less than 1,250 pounds, he would have been looked upon with suspicion, and yet a number of cars have been built and are running, that are within these figures.

New Alloys.

Much of this has been due to improved methods of production in the foundry, and to a careful analysis and testing of the metals used there, which has resulted in greater strength and better wearing qualities being obtained by different combinations of the old alloys and the addition of new ones. This permits the castings to be made of a thinner section, which results in reducing the weight.

As the power of the engine increased, so also did its revolutions per minute. This required a bearing with greater wearing qualities and less liability to heat under high speed. The compression in the engine was made greater which resulted in a greater expansion of the gases when they were exploded and a consequent greater thrust on the connecting rod and crank shaft bearings, and this necessitated bearings cast of metal that was hard enough to resist this thrust. Many patented and secret combinations of bearing metals, as well as metals which require other properties of strength in castings, have been placed on the market in the past few years. Some of these patented combinations have been known to foundrymen for a number of years but the secret combinations make me laugh, as any of them can be analyzed by the foundry chemist in a few hours at a slight cost, and if worth anything can be manufactured.

Secret Combinations.

A few of these patented and secret combinations of alloys for bearings have merit and are an improvement over the old methods and alloys produced, but the variety of alloys on the market that are valuable in the production of bearing castings are within the reach of every foundryman, and a little study of these, with a trying out of the product, will enable most foundries to produce bearings that are the equal of those advertised as extra, high grade, special, etc.

Much has been written on bearing alloys from the chemist's and scientist's point of view that is theoretically correct, but when many of these combinations have been given practical working tests, they have failed to give satisfaction. Some of the ingredients of these different bearing alloys are copper, tin, lead, zinc, phosphorus or phosphor-tin, antimony, aluminum, cadmium, and nickel, and some of the combinations in which they are cast are shown in Table I.

Copper.

Copper is the basic ingredient in all the different bearing metals, except the babbitt or white bearing metals, and is used on account of its great ductility combined with heat resisting powers. Its properties and characteristics are too well known to foundrymen to go into any lengthy discussion of them here. Lead added to the copper tends to soften and render it more plastic. Thus, when the bearing becomes warm the lead has a tendency to flow, allowing the globules of copper to support and bear the friction of the shaft running in it. Too much lead is liable to cause the bearing to squeeze out at the ends and too little does not allow the copper to act as it should. The lead lengthens the life of the bearing by diminishing its wear and is the best wear-resisting metal known. It also slightly increases the friction of the journal. It will not combine with copper below a white heat, unless the copper has been melted with tin previously, and the larger the amount of tin the more perfect will be the combination of the lead with the copper. This high temperature necessitates the use of a special furnace for making copper-lead alloys. Tin added to the above in proper proportions adds to the rigidity of the metal, hardens it without increasing its brittleness, and produces alloys of a compressive strength that is high enough for nearly all purposes. When the metal is etched and examined under a microscope, it shows hard, white, cube-shaped crystals, embedded in soft matrices, which seem much harder than the matrix. At the same time tin has a tendency to diminish the life of the bearing metal by increasing its rate of wear.

Phosphorus.

Phosphorus is usually added in the form of phosphor-tin, as it is much less dangerous to the eyes to handle in this form, and is mixed with the metal a great deal better. Some place a small stick of phosphorus on top of the molten metal in the ladle when it is drawn from the furnace, but it is a question whether this does any good or not, as it merely floats on the top and does not penetrate the mass of the metal. Its function in the production of phosphor bronze bearings is to make the metal more homogeneous by preventing the formation of pin holes which are liable to occur in copper and tin alloys, but

if too much phosphorus is added it will cause pin holes. Five per cent of phosphor-tin or 0.25 of phosphorus is about the limit that can be added to produce the desired results. Phosphorus is seldom used in alloys containing zinc, and then only with the zinc in very small percentages, owing to its adding, in a very marked degree, to the formation of pin holes. The phosphorus, after doing its work, oxidizes out and an analysis of the phosphor-bronze castings only shows a trace of phosphorus.

Zinc.

Zinc is used in bearing metals to a large extent in place of tin for the purpose of cheapening the product, as it is less expensive than tin. It produces brittleness and reduces the toughness which tin gives to bearing metals, and if it exceeds 33 per cent of the mass by weight in its alloy with copper, it produces a metal too brittle to be of any use. Its atomic weight and specific gravity is less than that of tin and experiments have proven that metals of a low atomic weight increase friction, while those of a high atomic weight reduce friction and are therefore the best to use for bearing metals. Combinations of copper, tin and zinc are, however, used successfully in producing bearing metals.

Antimony.

Antimony is sometimes added to the above alloys to harden them, but can only be used in small quantities, as it aids in the formation of a crystalline structure, produces brittleness and is a very poor wear restricting metal. For the babbitt or white metal bearings, antimony is used in quite large percentages. An alloy known as antimonial lead is used for some purposes, on account of its cheapness.

Aluminum.

Aluminum is sometimes used in these alloys, as it oxidizes on the surface of the metal when it is poured and forms a smooth, silky protective skin which prevents the volatilization of spelter and as all cast bearings are finished before using this skin is machined off. Aluminum, being very low in atomic weight, does not wear well as a bearing metal, as it increases the friction, but a small percentage aids in the production of good smooth castings of the bronze bearing metals. A white bronze bearing metal is being marketed which contains about 50 per cent aluminum, from 25 to 30 per cent zinc and from 20 to 25 per cent tin, but not having seen any tests of its wearing qualities and ability to withstand the shock stresses of an explosive engine, cannot give any opinion on it.

Table I.

Kind of bearing.	Copper.	Lead.	Tin.	Phosphor Tin.	Zinc.	Anti-mony.	Alum-inum.	Nickel.	Cad-mium.
Friction	90.0	....	9.0	1.0	....	....	....	....	....
Friction	88.0	3.0	8.0	1.0	....	....	....	....	....
Medium pressure friction..	78.0	12.0	8.0	1.0	1.0	....	....	....	....
High pressure friction.....	80.0	8.0	10.0	2.0	....	....	....	....	....
Locomotive	89.0	1.4	9.6	....	....	....	....	....	....
Penna. R. R.	77.0	15.0	8.0	....	....	....	....	....	....
Tough	77.0	....	11.5	....	11.5	....	....	....	....
Engine	89.4	....	10.4	.....	0.02	....	....	....	....
Heavy	84.2	....	13.2	....	2.6	....	....	....	....
Heavy	84.0	....	14.5	1.5	....	....	....	....	....
Heavy	82.0	4.0	12.5	1.5	....	....	....	....	....
Machinery	87.5	....	....	12.5	....	....	....	....	....
Hard piston ring	78.0	....	....	22.0	....	....	....	....	....
Nickel	65.0	29.0	....	5.0	....	....	....	1.0	....
Copper	92.0	....	....	8.0	....	....	....	....	....
U. S. Government bearing.	6.0	....	1.0	....	¼	....	....	....	....
U. S. Government friction.	3.7	....	88.8	....	....	7.5	....	....	....
Licensed Ass'n Automobile Mfrs. No. 1	4.0	....	89.0	....	....	7.0	....	....	....
Licensed Ass'n Automobile Mfrs. No. 2	....	75.0	10.0	....	....	15.0	....	....	....
Siemens and Halske, Berlin	....	....	....	....	47.5	5.0	....	....	47.5

Nickel.

Nickel is added in quantities of one per cent to some alloys of bronze bearing metals to lower the temperature at which it solidifies, so that the mass will not squeeze out any part of the free lead or lead that may not have combined with the copper, when the latter contracts in the act of solidifying.

Cadmium.

Cadmium is added to one alloy produced and patented in Germany, which contains from 45 to 50 per cent cadmium, 45 to 50 per cent zinc, and from 5 to 10 per cent antimony, and it is claimed for this bearing that it is far superior to the white metal bearings in that it is very easily worked and particularly easily turned, that it fills the mold completely when cast, that it has relatively great hardness, and more important still, that it has an extremely small coefficient of friction. If the proportions of cadmium and zinc are varied the coefficient of friction increases and other good properties of the alloy are prejudiced.

Bismuth.

Bismuth is sometimes added to bearing metal alloys in small quantities, as it gives the alloy the property of expanding the instant it solidifies, thus insuring the filling of the mold by the metal, and this makes it very useful when the bearings are cast in metal molds, but when sand molds are used for casting its beneficial effects are questionable. When used it should be added to the alloy just before pouring into the mold, as it is very fusible and causes other metals to become fusible.

Mixing Metals.

A general rule to follow when mixing bearing metals is to melt the metal having the highest fusing point first and add the other alloys in the order in which their fusing point descends, thus keeping the more easily melted metal for the last one to be added. The surface of the molten metal should be kept well covered with powdered charcoal to a depth of at least ¼-inch, and each alloy as it is added should be well stirred with a rod to insure a perfect mixture before the next alloy is added.

The alloys should never be allowed to remain over the fire and cook, but should be poured into ingots and remelted when wanted for castings. In nearly all cases this is the better method to pursue, as a remelt insures a more perfect mixture, or when a mixture of four ingredients is used, the one with the lowest fusing point can be left out, the other three melted, stirred, run into ingots, and when required for castings the ingots can be melted, the fourth alloy added, and 0.25 per cent of bismuth, by weight, well stirred in and the whole poured into the mold. The bismuth should be added after the pot or crucible has been removed from the furnace and while steadying it with the tongs.

Corrosion.

If the chemical corrosion could be overcome in a bearing metal that would be hard enough to withstand the shocks from an explosive engine and not run or squeeze out of the end when subjected to a shaft running at a high rate of speed, yet soft enough not to wear on this same shaft by possessing properties that were anti-frictional, the parts would

last for an unlimited time and the ideal bearing would be obtained. By keeping the surfaces of the bearing and journal separated by a film of oil there could be no metallic attrition if it were not for the chemical corrosion of the surfaces and while, in automobile practice, the very best of oils attainable are used, yet the metals will corrode, especially when brought into rubbing contact under pressure, and the passage of the oil removes the oxide as soon as it is formed, thus exposing the bright metal to further action.

Atomic Weight.

Of the metals used for bearings zinc is the most easily corroded. Lead does not corrode as easily as zinc. Copper and iron do not corrode as easily as lead. Tin, antimony and aluminum do not corrode at all, and the atomic weights, which have a bearing on the anti-frictional qualities of these metals, are as follows:

Copper, atomic weight	63.5
Tin, atomic weight	118.0
Zinc, atomic weight	65.2
Lead, atomic weight	207.0
Antimony, atomic weight	120.0

Metals to Be Mixed.

In the mixing of these alloys only the purest of metals should be used, as the impurities in the cheaper grades are liable to spoil all of the good effects of the metal and under no consideration should scrap of an unknown composition or method of previous treatment and fusing be used, as 10 per cent of scrap of a different composition from that desired will neutralize all the good qualities of the compound sought. While it is impossible to form a combination of any of the known alloys that will produce a perfect bearing metal, much progress and improvement has been made along this line and we probably see the highest type of these bearings on the automobile, as no expense is spared to get the best that the market affords, especially for high priced cars. As the perfect bearing for all purposes is not obtainable, a resource is had to different combinations of alloys for different parts of the car and for different purposes. Therefore on the crank shaft and connecting rod of the engine a hard phosphor bronze bearing is usually used, which is generally composed of from 80 to 90 per cent of copper, from 10 to 20 per cent of tin, and a trace of phosphorus and sometimes from ¼ to 2 per cent of zinc is used with a corresponding reduction of the tin component. The zinc is usually treated by the addition of copper phosphide, as in this manner the oxides are reduced, which if left in the metal after its solidification would cause zones of brittleness.

Zinc, however, should not be used where closely defined mechanical properties are desired and the zinc component seldom exceeds 1 per cent for engine bearing castings. The following table shows the mechanical properties of the copper-tin phosphor bronzes:

Grade.	Component of tin Per cent	Tensile strength Pounds	Elastic limit, Pounds	Elongation in 2 inches, Per cent
Extra hard	20	28,000	28,000	
Extra hard	18	33,000	27,000	
Very hard	16	40,000	26,000	1
Very hard	14	41,000	25,500	2
Hard	12	44,000	24,000	5
Hard	10	47,000	22,000	9

Bearing Containing a High Percentage of Lead.

The bearing bronzes containing lead are not as commonly used as the above, but there are quite a number of automobile engineers that demand them and a typical one of this class contains 65 per cent copper, 30 per cent lead and 5 per cent tin. It requires a good deal of skill to produce a homogeneous alloy of this kind, as it must be poured very hot into a cold mold to insure rapid cooling and thus cause the lead to solidify instantly so as to prevent the segregation which always takes place when more than ten per cent of lead is added to copper. Some add to this mixture 1 per cent of nickel, as this aids in the rapid cooling and prevents segregation by increasing the temperature at which the metal begins to solidify by forming a sort of metallic network, which prevents the lead from passing to the outside or to the bottom. It also makes it necessary to pour this alloy at a very high temperature. These lead bronzes will assume a high polish and not wear much as the lead separates from the alloy and forms on the surface, but they are better for anti-friction bearings than for bearings which have to support a load or stand the thrust of explosive engines, as they are very low in elastic limit to compression. Where the pressure is below 65,000 pounds to the square inch it makes an excellent bearing.

High Friction Bearings.

For bearings which have to withstand very little pressure and a large amount of friction, the standard U. S. government anti-friction bearing is about as good as anything that is made. This is composed of 88.8 per cent Banca tin, 3.7 per cent of copper, and 7.5 per cent of regulus of antimony, well fluxed with borax and rosin in mixing. This should be cast vertically. Where this mixture has failed to make good it has almost invariably been proven on examination that lead has been substituted for tin, or zinc was one of the components which is worse than lead, or that a cheap grade of tin which contained impurities was used.

Several of the guaranteed genuine babbitt metals on the market show a percentage of lead or zinc or both, as well as some of the patented and secret white bearing metal alloys, but by adding to the price and then giving a guarantee, the makers of these bearings can replace those that are returned and then show a good profit at the end of the year. By a study of the ingredients, a careful mixing of them, the non-use of scrap, not cooking the metal, and care exercised in molding and pouring the cast bearings, any foundry can turn out bearings that will stand the friction, or bearing bronzes that will stand the heavy loads and hard thrusts demanded by the automobile trade, and if they will stand the wear and shock stresses of the automobile they will be suitable for nearly any other line of machinery.

TRADE PPUBLICATIONS.

INDUSTRIAL RAILWAYS.—The Cleveland Car Co., West Park, O. Special catalog, 64 pages. Describes the complete equipment manufactured by this company for industrial railways, including cars for mines, steel mills, foundries, coke ovens, boiler rooms, etc.; track supplies, including switches, frogs, crossings, steel ties, rail supplies, portable track, etc., and other accessories, consisting of turntables, dump buckets, overhead trolleys, wheels and axles, transfers, foundry ladles, etc. The catalog is handsome typographically and well illustrated. It is compiled in loose leaf form that additional pages may be inserted from time to time.

CORE MACHINES.—Brown Specialty Machinery Co., Chicago, 20 page catalog. This work is printed in two colors on tinted paper. It is devoted to a description of the Hammer core machine, patented about six years ago by J. L. Hammer. When first introduced this machine was equipped to make only straight round cores, three-eighths to 1½ inches in diameter. Its capacity was later increased and last year a machine was placed on the market for making cores up to three inches in diameter, and for making cores less than three-eighths inches. Many irregular shaped cores can also be made, including square, oval, hexagonal, etc., provided they are of uniform size and diameter through their entire length. This concern manufactures only one machine, a different tube and bit being required for each size core, and as they are all interchangeable, each fits the one machine. The force feed is shown in section, which insures a steady and regular feed and supplies sand to the conveyer as long as there is any in the hopper.

VENTILATING THE BRASS FOUNDRY

A Plea for Healthful Conditions in the Grinding, Polishing, Tumbling and Sand Blast Departments

BY WALTER B. SNOW

IN MUCH of the early work done for the welfare of the employe there was a strange confusion of motives. Even though the project was primarily humanitarian in its spirit, the advertising department got in its work in proclaiming this spirit to all the world. But out of this confusion has now grown a definite recognition of the purely economic advantages of surrounding the workman with healthful conditions. While some other industries are more directly harmful to the health than is the brass industry, there is, nevertheless, ample opportunity within its field to greatly improve the conditions. Although the heat and fumes are primarily uncomfortable and only secondarily injurious, the greatest harm is done by the dust which is inhaled. This dust is usually of mineral or metallic origin resulting from the grinding, polishing, tumbling, and sand blasting processes, and also from the shaking out of the castings.

Injurious Industries.

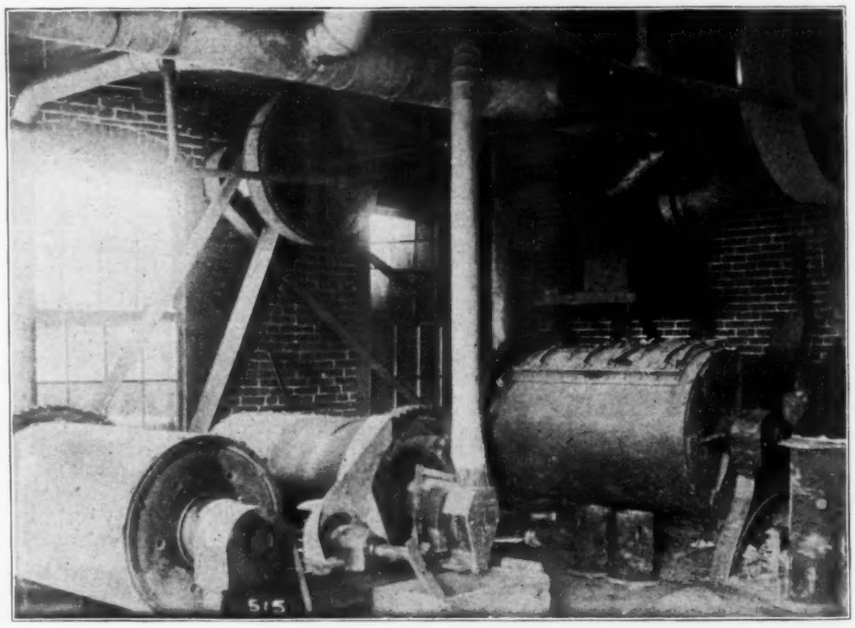
It is commonly recognized that life is shortened by working in a dust-laden atmosphere, but the extent to which some industries are injurious is startling. In the cutlery and tool industry, which is declared to be one of the most dangerous of trades in this class, the average age of the operatives at death is exceedingly low and in establishments conducted without proper hygienic precautions sound men are rare after a few years' work. The prevailing cause of death is consumption, which usually overtakes a susceptible worker so early that his period of usefulness does not extend much beyond five or six years, except where the health is properly safeguarded.

The testimony of physicians is, that of those employed in this industry nearly all who reach the age of 40 die of consumption, excepting those who succumb to some acute disease. As proof of this statement, it is instructive to note that in Northampton, Mass., an important seat of the cutlery industry, the death rate from tuberculosis for the entire male adult population was 2.9 per thousand, while that for the cutlers of that town was four times as great, namely, 11.8 per thousand. The trouble lies not so much in any directly poisonous results from inhaling the dust as in its power to bring about constant irritation, which produces such a condition of the mucous surfaces that they more readily admit of invasion by disease germs. Fortunately brass is less irritating than steel, and consequently the results in the brass industry are not as disastrous as they are among the cutlers. But the dust of corundum and emery is peculiarly irritating, and the brass workers' surroundings are therefore susceptible of marked improvement.

Laws to Safeguard Health.

The unhygienic conditions existing in the various industries have received the attention of State Boards of Health, whose official investigations are bringing about the passage and enforcement of more stringent laws looking to the safeguarding of the health of the employes in all industrial establishments.

In a word, advance has been made from a matter of individual interest to one of almost national importance. The statute books of the leading states of the Union already contain laws, usually somewhat vague in their expression, which require cleanliness, light, warmth, ventilation, and the introduction of specific devices for removing dust, fumes, and the like. While the first impulse of the manufacturer may be to resent the enactment of further laws, yet his compliance with them is not without eventual advantage. Not only will a better class of men prefer to work for him if improved conditions are provided, but there will be far less interference with work because of sickness, more energy in the work which is done, and less loss by death of the potential value possessed by the man who has become thoroughly skilled in a given line of work Continued sickness and death naturally mean constant replacement of individuals, with the loss of knowledge and skill gained by those who have gone. As



TRUNNION EXHAUST FROM TUMBLING BARRELS

*Presented at the Philadelphia Convention of the American Foundrymen's Association.

METHOD OF CALCULATING MIXTURES FOR THE CUPOLA.

Analysis of the castings required.

	Per cent.
Silicon	1.60
Phosphorus	0.70
Sulphur ..... less than	0.10
Manganese	0.50

From previous experience with the iron and coke, due consideration being given to local melting conditions, it is estimated that the approximate loss of silicon will be 0.25 per cent, and manganese 0.10 per cent, while the increase in sulphur will be approximately 0.03 per cent.

The average analysis of the iron and scrap to be charged should be as follows:

	Per cent.
Silicon	1.85
Phosphorus	0.70
Sulphur ..... less than	0.07
Manganese	0.60

Tabulation of the Material to be Charged and Method of Figuring the Mixture

KIND OF MATERIAL.	Weight in Pounds	ANALYSIS. Silicon Per Cent	Sulphur Per Cent	Phosphorus Per Cent	Manganese Per Cent	WEIGHT OF* Silicon	Sulphur	Phosphorus	Manganese
Steel Scrap	400	0 10	0.07	0.10	0.60	0.40	0.28	0.40	2 40
Machinery Scrap	2,000	1.70?	0.10?	1.00?	0.60?	34.00	2.00	20.00	12.00
High Sulphur Southern	1,600	0.70	0.10	1.50	0.30	11.20	1.60	24.00	4.80
X No. 1	1,600	3.00	0.03	0.80	1.25	48 00	0.48	12.80	20 00
No. 3 Foundry	4,000	1.75	0.07	0.30	0.60	70.00	2.80	12.00	24.00
High Silicon Iron	800	3.50	0.025	0 07	0 60	28.00	0 20	0.56	4.80
Total	10,400					191.60	7.36	69.76	68 00
					Average Per Cent	1.84	0.071	0.67	0 65

*Multiply the weight of each kind of material by the per cent of the element in it, then divide the total weight of each element by the total weight of the material which in this example is 10,400 pounds.

By the relative adjustment of the pig iron and scrap, mixtures for any desired analysis can be made.

DATA SHEET NO. 3. THE FOUNDRY, OCTOBER, 1907.

CHORDS OF ANGLES FROM ONE TO NINETY DEGREES.—DIMENSIONS GIVEN IN INCHES.

Ang. Deg.	18″ Radius Chord	36″ Radius Chord	72″ Radius Chord	Ang. Deg.	18″ Radius Chord	36″ Radius Chord	72″ Radius Chord
1	5/16	5/8	1 1/4	46	14 1/16	28 1/8	56 17/64
2	5/8	1 1/4	2 1/2	47	14 23/64	28 23/32	57 27/64
3	15/16	1 7/8	3 3/4	48	14 41/64	29 9/32	58 37/64
4	1 1/4	2 1/2	5	49	14 59/64	29 55/64	59 23/32
5	1 37/64	3 9/64	6 9/32	50	15 7/32	30 27/64	60 55/64
6	1 7/8	3 49/64	7 17/32	51	15 1/2	31	62
7	2 13/64	4 25/64	8 51/64	52	15 25/32	31 9/16	63 1/8
8	2 1/2	5 1/64	10 3/64	53	16 1/16	32 1/8	64 1/4
9	2 53/64	5 41/64	11 19/64	54	16 11/32	32 11/16	65 3/8
10	3 9/64	6 9/32	12 35/64	55	16 5/8	33 1/4	66 1/2
11	3 29/64	6 29/32	13 51/64	56	16 29/32	33 51/64	67 39/64
12	3 49/64	7 17/32	15 3/64	57	17 11/64	34 23/64	68 23/32
13	4 5/64	8 5/32	16 19/64	58	17 29/64	34 29/32	69 13/16
14	4 25/64	8 25/32	17 35/64	59	17 23/32	35 29/64	70 29/32
15	4 45/64	9 25/64	18 51/64	60	18	36	72
16	5	10 1/64	20 1/32	61	18 17/64	36 35/64	73 5/64
17	5 21/64	10 41/64	21 9/32	62	18 35/64	37 5/64	74 11/64
18	5 5/8	11 17/64	22 17/32	63	18 13/16	37 5/8	75 1/4
19	5 15/16	11 7/8	23 49/64	64	19 5/64	38 5/32	76 5/16
20	6 1/4	12 1/2	25	65	19 11/32	38 11/16	77 3/8
21	6 9/16	13 1/8	26 15/64	66	19 39/64	39 7/32	78 27/64
22	6 7/8	13 47/64	27 31/64	67	19 7/8	39 47/64	79 15/32
23	7 11/64	14 23/64	28 45/64	68	20 1/8	40 17/64	80 17/32
24	7 31/64	14 31/32	29 15/16	69	20 25/64	40 25/32	81 9/16
25	7 51/64	15 37/64	31 11/64	70	20 41/64	41 19/64	82 19/32
26	8 3/32	16 13/64	32 25/64	71	20 29/32	41 13/16	83 5/8
27	8 13/32	16 13/16	33 5/8	72	21 5/32	42 21/64	84 41/64
28	8 45/64	17 13/32	34 13/16	73	21 13/32	42 53/64	85 21/32
29	9 1/64	18 1/32	36 1/16	74	21 21/32	43 21/64	86 21/32
30	9 5/16	18 41/64	37 17/64	75	21 59/64	43 53/64	87 21/32
31	9 5/8	19 15/64	38 31/64	76	22 5/32	44 21/64	88 21/32
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35	10 53/64	21 21/32	43 19/64	80	23 9/64	46 9/32	92 9/16
36	11 1/8	22 1/4	44 1/2	81	23 3/8	46 3/4	93 33/64
37	11 27/64	22 27/32	45 11/16	82	23 39/64	47 15/64	94 15/32
38	11 23/32	23 7/16	46 7/8	83	23 55/64	47 45/64	95 13/32
39	12 1/64	24 1/32	48 1/16	84	24 3/32	48 11/64	96 23/64
40	12 5/16	24 5/8	49 1/4	85	24 21/64	48 41/64	97 9/32
41	12 39/64	25 7/32	50 7/16	86	24 35/64	49 3/32	98 13/64
42	12 29/32	25 51/64	51 39/64	87	24 25/32	49 9/16	99 1/8
43	13 3/16	26 25/64	52 25/32	88	25	50 1/64	100 1/32
44	13 31/64	26 31/32	53 15/16	89	25 15/64	50 15/32	100 15/16
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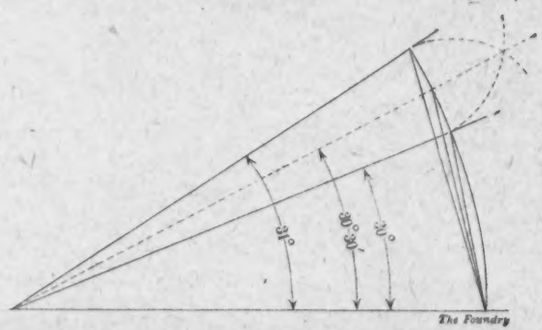


Chords of intermediate angles can be obtained as shown on the diagram.

DATA SHEET NO. 4. THE FOUNDRY, OCTOBER, 1907.

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note-book form.

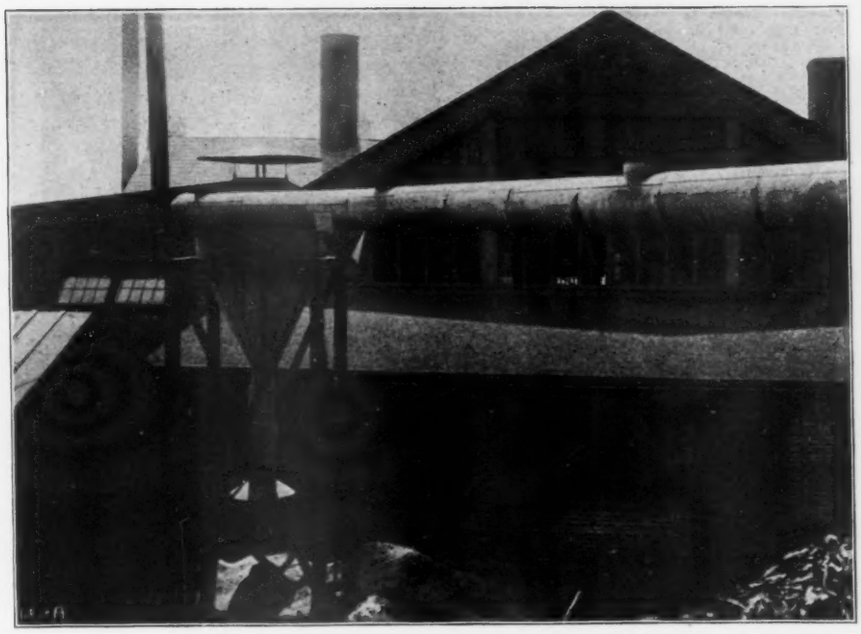
THE FOUNDRY DATA SHEET, OCTOBER, 1907.

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication.

a result there is far less stability of employment in an unhealthy industry.

Ventilating Appliances.

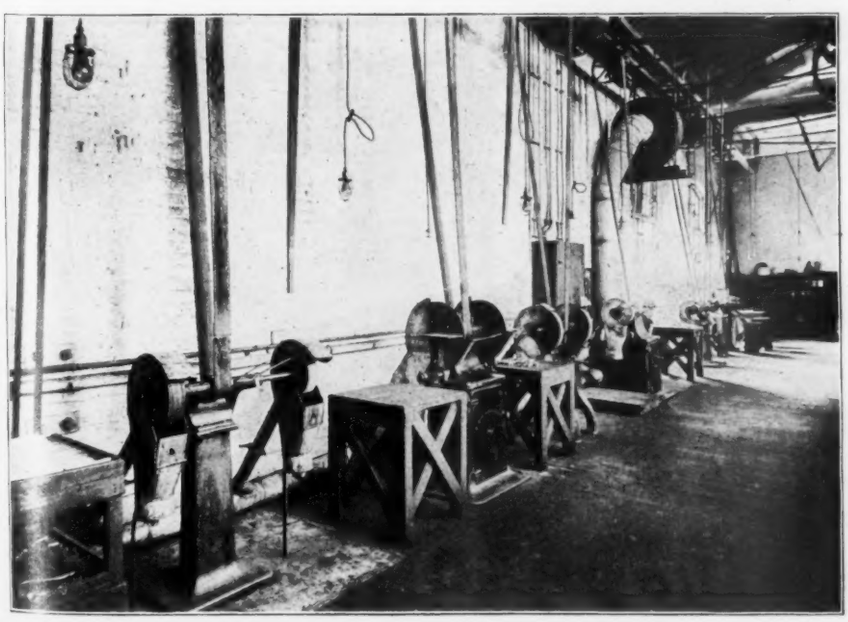
Experience has shown, and the reports of investigations confirm the fact, that mechanical means are absolutely necessary to maintain a rapid air change or to insure proper removal of dust. In fact the fan blower figures everywhere as the only device adapted to secure these results. It is manifest that the action must be positive, and of sufficient intensity to create ample movement of air. Where there is but little dust or the requirements of ventilation are slight, a fan applied for mere renewal of air throughout the entire extent of a room will meet the requirements. When warranted by the size of the plant the fan may form part of a blower heating system, by means of which warm air from a centralized heater is delivered under pressure through pipes to all parts of the building. In overheated rooms and particularly for summer ventilation the disc or propeller type of fan meets the requirements if placed in wall or ceiling.



ARRANGEMENT OF DUST COLLECTOR WITH CLEAN-OUTS IN PIPE AND FREE DUMP FOR DUST

Wherever dust or fumes are formed locally, as in connection with grinding and polishing wheels, tumbling barrels, or furnaces, the exhaust should be direct from hoods which enclose the objectionable source as completely as possible. In a word, prevention is better than cure. The objection which is often shown by workmen to hoods and similar contrivances—even to the extent of actual destruction—is largely due to their improper construction. In fact the cause for condemnation or criticism of many exhausting systems lies in the method of application of the fan, and not in the fan itself. The success of the fan not only depends upon its speed and its proper proportioning to the work, but also upon the system of piping and hoods which would give the greatest efficiency. It seems so simple to employ a local tinsmith to rig up an exhausting system that it is not strange that unsatisfactory conditions result.

It is far better policy to secure the best advice, which will always be freely given by blower manufacturers, and then have the thing done right. It must not be overlooked that the installation of an economical exhausting arrangement requires definite engineering ability, and should only be undertaken by one who makes a specialty of this particular class of work.



A MODEL EXHAUSTING ARRANGEMENT WITH MAIN PIPE ON FLOOR

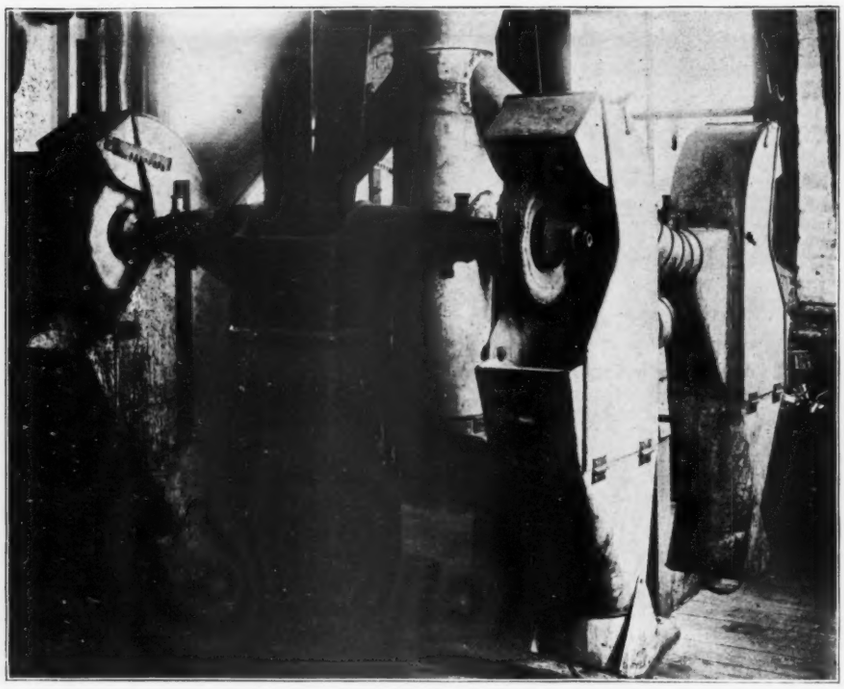
Cost of Installation.

Because of the lower first cost the user is always strongly tempted to buy the smallest apparatus that can be made to do the work. But first cost is only one of the factors in the total cost. Large slow running fans with ample pipe areas are conducive to small power expenditures. It is easy to save enough in power in six months to pay the additional cost of a more efficient outfit or system. Thereafter its economy is all clear gain.

Even though the fan be of ample size when first installed, it may, as a result of speeding up to meet added requirements, frequently demand from 50 to 100 per cent more power than would be necessary to do the work with a proper outfit. It is none too generally understood that the power required to drive a fan increases as the cube of the speed. In other words, that doubling the speed calls for an eight-fold increase in power, while 27 times the power is required at three times the speed; an increase of only 25 per cent in speed calls for nearly double the power, and yet such an increase is common enough. How long would it take to pay for a new outfit from the money thus squandered in excessive power?

Design of Hoods.

The designs of hoods for grinding, polishing, or buffing wheels are many and varied. Each must be arranged to suit the particular class of work for which the wheel is used. In some cases it is even necessary to have several dif-



ARRANGEMENT OF HOODS FOR UPWARD EXHAUST

ferent types in the same room. This is true where the pieces are of such shape and size that it is impossible to get very close to the wheel, the result being that at one time the operator uses the wheel at a point near the top, and again at a point directly underneath. Under these conditions especial care must be taken to provide the most effective type of hood and maintain the maximum blast. In heavy work of this type the air suction pipe should be five inches in diameter for wheels up to and including 16 inches in diameter by three-inch face. In ordinary grinding and buffing rooms the suction pipes should be four inches in diameter for wheels 2½ inches or less in width, and from 10 to 18 inches in diameter. Wheels ranging from 19 inches to 28 inches should have five-inch or six-inch pipes according to class of work for which they are used.

All hoods should be so designed that the velocity through the openings should not be less than 5,000 feet per minute, which is usually sufficient to create the draft necessary to carry away the particles. The best general type of hood is of patented form, provided with a receptacle below to trap out all heavy particles, as well as the threads from the buffing wheels, while allowing the finer dust to pass through the pipe. The result is that the metallic particles are left in clean condition ready for resmelting, and the wear on the pipes and the fan is greatly reduced. This arrangement also prevents the annoyance caused by the dust from the rag wheel adhering to the fan wheel and throwing it out of balance. The trapping-out feature furthermore permits of the ready recovery from the bottom of the hood of any small piece of work or other material, which with other types of hoods might get into the main trunk line or up into the fan.

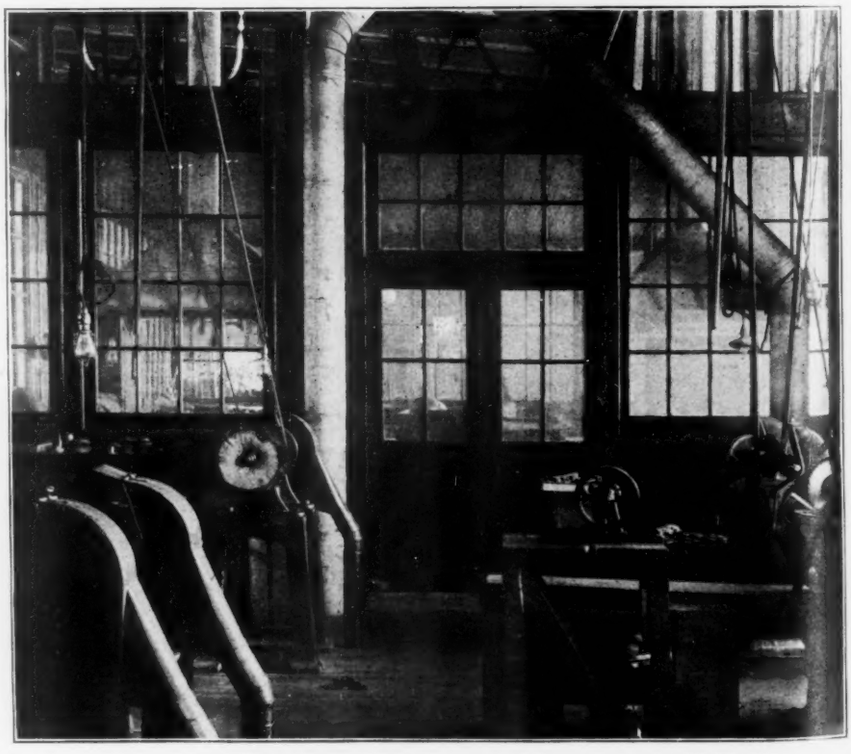
All properly designed systems should have clean-cut caps so as to provide free access to the interior of the piping for the removal of anything that might possibly tend to clog it. The main suction pipe should be proportionately increased in size as each connection is made to it.

Fan Installation.

To secure the most economical results a fan should be chosen which has an area of inlet about twice the combined area of the inlet pipes. This proportion will give the maximum velocity through the branch pipes and hoods. The fan should then be operated at about 1½-ounce speed, under which condition it would consume about ½-horsepower for each four-inch opening.

The most work is done, and consequently the most power is required by a fan when it is discharging with free inlet and outlet. The more extended the system of piping, the smaller the area of inlet or outlet; and the greater the friction, the less will be the volume delivered by the fan; and consequently the less will be the power required to drive it. It is therefore manifest that the fact that the fan is consuming but little power is not always evidence of its successful operation, for it may be doing little effective work.

The dust which is collected by the fan should be discharged into a centrifugal dust collector. Here the dust is separated from the air by centrifugal force; the air escapes from the top practically free from dust, while the dust itself drops out of the bottom through a pipe.



EXHAUSTING ARRANGEMENT WITH PIPES CARRIED BENEATH THE FLOOR

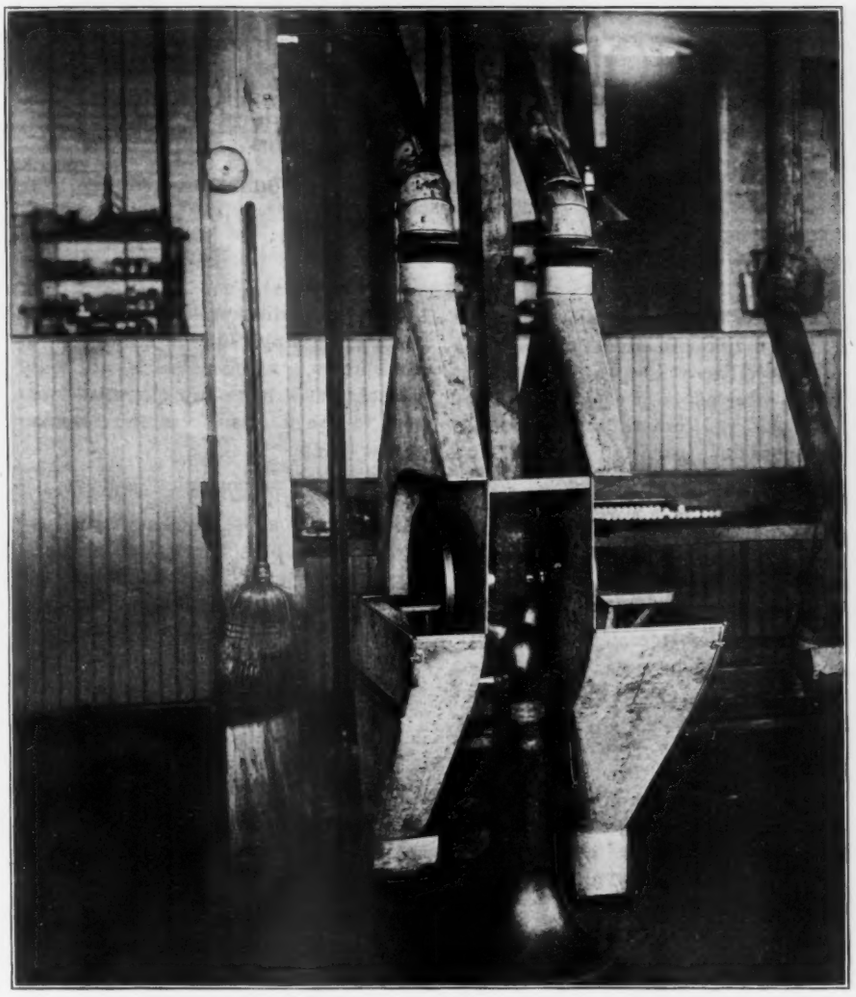
It should be periodically removed. The dust from wheels grinding iron and steel should not be mixed with that from rag wheels, for in some cases fire will result. Separate fans and systems should be used.

Exhausting from Tumbling Barrels.

The same general principles hold in connection with systems exhausting from tumbling barrels. If the maximum effect of the fan is desired on tumbling barrels equipped with hollow trunnions, the area of fan inlet should be about double that of the sum of the openings in the trunnions. The sizes of pipes and the speeds of fans to be applied in connection with housed rattlers must depend largely upon the conditions, but a six-inch pipe connection will usually serve for each tumbling barrel, if the same is tightly enclosed. A fan running at about one ounce speed will give sufficient draft.

No general rules can be given for the application of the fan system to sand-blast rooms or apparatus. The arrangement must depend entirely upon the local conditions, but the provisions must be generous if successful results are to be obtained.

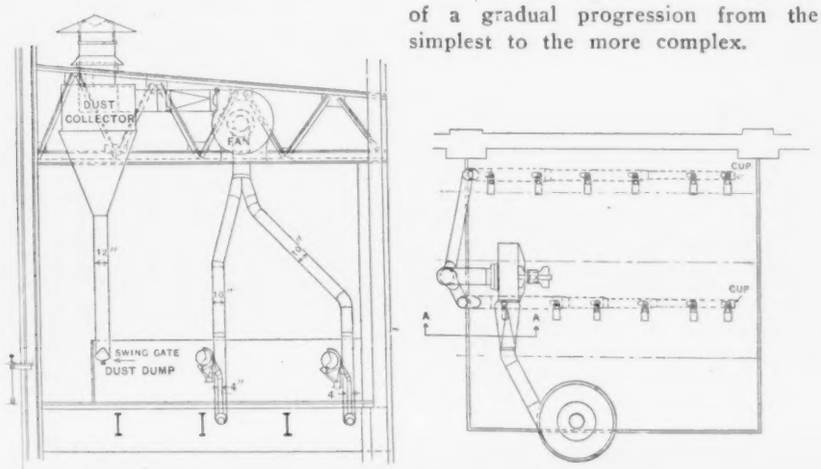
With installations such as are here described it is possible to maintain a relatively healthy atmosphere, which is bound to insure better work.



GRINDING DISCS EQUIPPED WITH SPECIAL HOODS DESIGNED TO GIVE FREEDOM TO WORKMEN

CORRESPONDENCE COURSE IN FOUNDRY PRACTICE.

W. W. McCarter, Marietta, Ga., has organized the "School of Associated Foundry Training," which provides correspondence courses in foundry work. The first series of 12 papers can be had at a cost of only $12. The instructions are given in terms as simple as the nature of the subject will permit and the student is put in possession of such principles as will enable him, without difficulty, to apprehend and appreciate the simplified methods employed in modern foundry practice. Adequate drawings accompany each paper applying to practical foundry work. The papers are furnished once a month and the plan of the work is of a gradual progression from the simplest to the more complex.



A TYPICAL EXHAUSTING ARRANGEMENT FOR BUFFING WHEELS, WITH PIPES BENEATH THE FLOOR

HENDRICK'S COMMERCIAL REGISTER.

The sixteenth annual edition of Hendricks' Commercial Register of the United States for buyers and sellers has made its appearance. The volume is especially devoted to the interests of architectural, mechanical, engineering, contracting, electrical, railroad, iron, steel, mining, mill, quarrying, exporting and kindred industries. It contains 1,224 pages with an index of over 350,000 names and addresses and upwards of 15,000 business classifications. The work is especially valuable as a buyer's reference. It is published annually by the Samuel E. Hendricks Co., 74 Lafayette street, New York, and is furnished at the price of $10 each, express charges prepaid.

The Leader Foundry Co., Quincy, Ill., has been incorporated with a capital of $15,000. The incorporators are: Charles H. Achelpohl, J. H. Vandenboom, and Henry F. Dayton.

METHODS OF CASTING YELLOW BRASS

Constituents of this Alloy—Use of Ingot Brass—Scrap—Aluminum—Iron in the Mixture

BY C. VICKERS

YELLOW brass is an alloy of copper and zinc. It is designated by the adjective yellow to distinguish it from all other alloys of copper, which are known as red brass. Yellow brass often contains lead and tin, as well as the two primary metals. These are added for specific purposes and have no bearing on the fact that an alloy of copper with zinc constitutes yellow brass. Lead is added because it facilitates the working of yellow brass. It makes it easier to file, turn and drill, but does not otherwise improve the alloy. About three per cent of lead is usually used. Tin imparts stiffness to yellow brass, and it is rare that more tin than two per cent is necessary to accomplish this result.

The term yellow brass has been used quite frequently in the above remarks. Theoretically all yellow alloys of copper are brass, red, or more properly golden colored alloys, being either bronze or composition, but as all copper alloys are universally known as brass, their only distinguishing characteristic to the lay mind is their color, hence the terms red brass and yellow brass. As the subject of these remarks is yellow brass, it will not be necessary to enter into any lengthy explanation of the differences existing between red and yellow brasses, or why the distinguishing adjectives are properly or improperly applied, but we will proceed to consider the treatment necessary to making yellow brass castings.

Method of Molding.

The molding is the same as for any other alloy of copper, a certain amount of skill is of course necessary, as the molds must not be rammed either too hard or too soft, and the sand must not be too wet or too dry. Some molders believe in a vigorous use of the vent wire on molds for yellow brass. I have seen patterns, brass ones too, for such small castings as the internal parts of bibs and faucets, all pitted and marred by the use of the vent wire to such an extent that they were ruined, as it was impossible to make perfect castings therefrom, since each little pit would be duplicated in the castings giving the appearance of sand holes. All of this is not only unnecessary, but an eloquent witness to the incapacity of the foreman of the shop.

Venting.

Such castings — plumbing goods — need no venting, even heavier castings of yellow brass as hand rail balls, and other railing trimmings, come very nice without the vent wire, and should it be found impossible to make such castings without such venting, then the sand is at fault and it is an economy to discard it and obtain sand that will produce good castings without venting. To follow up the question of sand, however, would carry us too far from our subject. Most molders on yellow brass vent their molds at the joint by scratching light channels from the patterns to the side of the flask, the idea being to let out the smoke. This is an excellent and necessary practice, for some kinds of work, such as chandelier and other thin castings, as it allows the advancing metal to push out the air before it, thus aiding in the filling out of light projections on the casting. It does not do much good on larger work, however, especially such as reaches up into the cope, for obvious reasons. It is good practice, however, to draw a needle vent wire through all high portions of the mold to give free egress to the gases, permitting the metal to run up sharp.

For heavy castings a thick vent wire or small riser is often used for the purpose of letting off the smoke from the metal which would give the castings a worm-eaten appearance at such points. In gating for yellow brass it is better to use a double gate leading into the casting wherever possible. This is a gate cut partly in the cope and partly in the nowel, thus being oval in section. The reason for this is that a gate cut entirely in one-half of the flask is liable to draw from the casting, leaving a shrinkage hole. A broad thin gate that will dam back the metal and permit the head being kept full while pouring is best for most classes of yellow brass castings.

Pouring.

Pouring is the most important part in making castings of yellow brass. Owing to the volatile nature of zinc the metal flares up so much when removed from the furnace at a casting temperature, that the surface of the metal cannot be observed. An inexperienced man might imagine, therefore, that he was pouring a good strong stream into the mold, when in reality he was merely dribbling it in. Indecisive pouring is fatal to the success of a casting, as no matter how carefully the mold is made, or how vented, if not properly poured, the result in the majority of cases is scrap. Yellow brass must be rushed into the mold in order to keep the head full. This prevents the air entering, forming oxide of zinc, which would give the upper surface of casting an unsightly streaked appearance. A good clean yellow alloy, poured with the precautions stated, will turn out as nice a casting as red brass. There should be no trouble in obtaining satisfactory castings of an alloy of 16 ounces of copper to eight ounces of zinc. The castings should leave the sand with a fine reddish skin, and be free from sand holes, smoke or any other defects. This applies when new metals are used.

Scrap.

With scrap it is different. Rolled scrap such as tubing, sheet brass, etc., turns out very nice castings. It will have to be leaded, however, to enable it to be more easily worked. Such scrap is comparatively low in zinc, generally much lower than ordinary cast brass, otherwise it could not be rolled, and one is therefore pretty safe in using such material. With cast scrap brass the case is different, as we cannot tell with any accuracy, from the face of it, what it contains. Ingot brass is the worst possible form in which to obtain brass, because the purchaser must rely absolutely on the honesty of the man who made the ingots. It is gen-

erally made from scrap metals in the first place, and the temptation to add more zinc, and often lead, proves irresistible to many dealers.

Ingot Brass.

Ingot brass is the source of most of the troubles that the yellow brass founder encounters, because it generally contains too much zinc or lead, or worst of all, iron. It should never be bought except by analysis, as pig iron is purchased. It is safe to say that all yellow ingots containing more than 35 per cent of zinc have been cheapened to give the maker a larger profit. Brass that is too high in zinc will not cast in sand. Lead also is a factor to be taken into consideration, but iron is the most injurious. Brass running higher than the limit in zinc or lead, if it is sold for what it really is, can be easily brought to grade by the addition of copper, but for brass containing iron there is no remedy, because, even if it were not difficult to cast, it is too costly to machine.

Iron.

Iron is introduced into brass in a variety of ways. In new alloys the use of iron furnace tools contaminates the metal, although the amount so introduced is immaterial as proved by the fact that the color of the castings is not changed. Whenever the quantity of iron begins to affect the color of the castings it will also affect their casting and machining qualities. Such metal is very inferior, entirely unfitted for the requirements of the plumbing trade, also for most of the uses to which yellow brass is put, and should be sold for what it is.

Light Yellow Scrap.

Light brass scrap, such as old lamps, clock movements and the thousands of other things that constitute the trash known as light yellow scrap, all contain more or less iron in the form of wire, screws, springs, etc. It is impossible to remove these except by melting the brass and skimming off the iron from time to time, and if through carelessness or ignorance the metal is allowed to become too hot, much of the iron is dissolved in the brass, producing a poor grade of ingot, therefore some system of standardizing yellow brass ingot is much to be desired.

Experiences with Ingot Brass.

It is a common experience with users of ingot brass that the first consignments from a new source of supply produce perfectly satisfactory castings and that subsequent consignments cause trouble. The castings are hard and difficult to machine or come out of the sand all pitted with what look like sand holes, just as if the molding sand had disintegrated and imbedded itself in individual grains in the skin of the casting, or else the castings are porous, being full of minute holes. Owing to the good reputation the first ingots have established, the source of the trouble is looked for anywhere but in the brass and the molders and melters are blamed, although they are in nowise responsible.

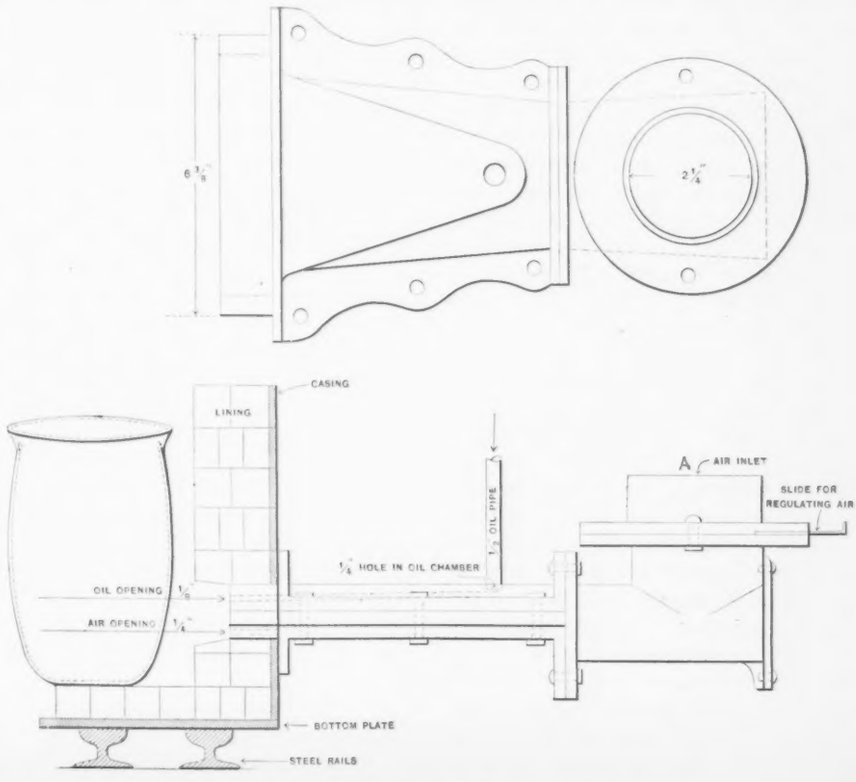
Aluminum.

Aluminum is being largely used at the present time in yellow alloys. It gives great fluidity to the metal, permitting it to be poured without flaring and still fills all parts of the mold perfectly. By using aluminum a much larger quantity of zinc can be alloyed with the copper, even as high as half and half, and beautiful appearing castings can be made. An alloy as high as this in zinc possesses no strength and is suitable only for decorative purposes. About three ounces of aluminum to 100 pounds of brass is sufficient to produce this result, and the castings will possess the red color of bronze internally, externally being a pretty lemon yellow.

AN OIL BURNER FOR BRASS FURNACES

BY LOUIS LUHRSEN

SEVERAL years ago we concluded to change our brass furnace from coke to crude oil. The available power at that time was one No. 8 Sturtevant fan which furnished the blast for our cupola and showed a pressure of 11 ounces on the blast gauge, length of blast pipe, 75 feet, with three turns in the pipe. During the greater part of the day, that is, up to blast time, this fan furnished the air for the brass furnace. We inserted a valve into the blast pipe to keep the wind from entering the cupola. We then tapped the blast pipe and bolted a flange on the same and into it a connection for a four-



AN OIL BURNER FOR BRASS FURNACES

inch galvanized iron pipe, which led to the burner of the brass furnace at A. The burner which we used is known as the Kline burner, shown herewith. It penetrated half way through a six-inch lining, and struck the crucible about five inches from the bottom. The flame striking square against it caused the flame to split, thus encircling the crucible and united again on top. This made a very hot fire.

Our furnace, not being of the tilting variety, this arrangement gave entire satisfaction. Of late our machinery department installed an air compressor and changed our furnaces accordingly. Both methods have something in their favor. There is one important factor in connection with this subject, namely, that the action of a fan blast is a great deal easier on the crucible than compressed air at 20 or 40 pounds pressure. We learned this after making the change from fan to compressor. In the latter case the nozzle of the burner was set at such an angle that it struck the lining instead of the crucible. The burner described could be attached to a tilting furnace by entering underneath the trunnion or a little to one side of it. It should be brought as close as possible to the casing, leaving just enough space to clear the furnace when pouring the metal. The opening through the casing and the lining should be large enough to enable the vapor (oil and air) to go into the furnace without striking the casing. The accompanying sketch also shows how we had the burner attached. In conclusion will say that we use a No. 100 crucible holding nearly 300 pounds of metal, half of which is copper. It required 1¾ hours for the first pot and using the same pot for the following heats it required one hour and ten minutes to melt the same amount.

BRASS FOUNDRY NOTES

BY C. VICKERS

QUESTION.—We are having some trouble in securing sound brass or bronze bushings for road roller bearings. The castings are eight inches long, four inches outside diameter and three inches inside. They are cast on end in green sand with dry sand cores. They have a great many holes ranging from the size of a pin head to a pea. Some are like sand holes and some have clean cavities and have the appearance of blow holes. We melt in a J. W. Paxson furnace and use a No. 30 crucible. We use coke as fuel with a cold blast under the grate. We are very careful not to let the metal get too hot, just liquid enough to flow freely. We use new metal, principally copper, tin, lead and zinc. We melt the tin, lead and zinc together and run it into bars containing two parts tin, one lead and one zinc. After the crucible is lifted out we put in one pound of the white metal to six pounds of copper and work in a little back scrap, such as chips, ends of bushings, etc.

Answer.—The cause of the difficulty in this case is undoubtedly due to cold pouring. The anxiety to avoid burning the metal has led to error in the opposite direction. Would suggest the following trial heat. Charge the crucible as usual with copper, adding a small handful of common salt. If too large a quantity of the latter is used, the fumes will not be burned before the metal is poured and the shop will be filled with a pungent and intensely irritating gas. When the copper begins to get red, add charcoal or pieces of hard wood and be careful to keep the metal well covered with charcoal when liquid. When the copper is melted, if it is thick and clings to the poker, do not add the mixture, but raise the temperature of the metal until it appears clear and limpid beneath this cover of charcoal. It may be necessary to raise and recool the pot to accomplish this, but be careful to see that it is done. Then add the mixture. The metal should be well stirred and permitted to stand a few minutes in the fire, when it will be ready for pouring. It is unnecessary to cast such bushings very hot, but have the metal hotter than you have been accustomed to pour, say at a bright red heat. Small bushings such as described are often molded horizontally, the patterns being split to make molding easier. We make a large number of bushings of this and larger sizes with a heavy flange on one end, and so far have never seen any spongy castings. They are generally made by an apprentice boy and are cast in a horizontal position, the patterns being split. A round gate is used, one-half being in the cope and the other half in the nowel. It is placed on the side of the bushing at one end. The molds are inclined when pouring, the heavy flanged end of the bushing being at the lower end of the flask farthest away from the gate. We use scrap metals exclusively and no extraordinary care is taken in melting. When bushings are cast vertically there is always danger from the sand and the manner of ramming the same. If the sand is too close or too damp and is rammed too hard, trouble may be expected with the casting. We find that it requires more skill to make bushings vertically than horizontally and cast all of our bushings in the latter position. Would suggest therefore a trial of this method of making the bushings, as well as pouring the metal a trifle hotter.

CAR BRASSES.

Question.—When melting car brasses containing a quantity of zinc we lose considerable of the latter due to its burning and rising to the top of the crucible in the form of heavy black skimmings. We would also like to know how to entirely avoid iron in brass made from scrap. Also give us a good brass flux.

Answer.—Car brasses are generally made of very poor material. What you are using is no exception to the general rule. The metal is heavily oxidized and what you believe is zinc burning out, is merely this oxide rising to the top of the metal.

Zinc oxide is white, not black, and when it burns out of brass the metal gives off a dense white smoke, which condenses in the air to flakes, that look like little snow-flurries.

To avoid the burning out of zinc as much as possible, do not let the metal get hotter than is absolutely necessary.

Your loss from skimmed-off dir will be much greater than from th burning out of zinc.

To avoid this trouble, use a better grade of scrap. It will probably cost more but is cheaper in the end. Examine the fracture of your scrap and you can readily see the dirt in it. Sometimes the metal looks as if it had been mixed with sand, it runs so high in oxides. Such brass is worthless to you. My advice is not to pur

chase any car brass scrap, as none of it is above suspicion.

The only way to entirely avoid iron in brass is to use no scrap, and if you do you must take your chances.

All visible iron in scrap, such as screws, rivets, etc., can be removed.

Sometimes the scrap will have to be heated and broken up to get out the iron. Sometimes it is melted at a low temperature, the pot removed from the fire and the iron skimmed off, when it is again replaced in the fire and heated to a temperature suitable for casting. There is no way to separate iron that is alloyed with brass. Repeated melting and skimming will help a little, but the iron is never entirely removed.

A good flux for brass is common salt.

DIGESTER FOR SULPHITE PULP.

Question.—Can you give us a mixture for an acid resisting brass to be used in connection with a digester for sulphite pulp?

Answer.—There is no such thing as an acid resisting brass, although some alloys of copper resist the action of acids better than others. In time any alloy will be eaten away by acid. Lead is the best ordinary acid resisting metal known, as it is always considered that the more lead that can be worked into a copper alloy the better it is for such purposes. The following alloy is based on this idea: Copper, 80 pounds; lead, 12 pounds; tin, eight pounds. A good gun metal which might be suggested for such work is as follows: Copper, 86 pounds; tin, nine pounds; lead, five pounds.

METALS IN FOUNDRY PRACTICE

Questions from Practical Foundrymen are answered in this department by the following experts

CAST IRON	W. J. KEEP
MALLEABLE IRON	DR. RICHARD MOLDENKE
METALLURGY OF STEEL	J. B. NAU
STEEL CASTINGS	W. M. CARR

OTHER EXPERTS ALSO CONTRIBUTE ADDRESS ALL INQUIRIES TO THE EDITOR

CAST IRON NOTES

BY W. J. KEEP

QUESTION.—We have a 50-ton cupola which we use for the manufacture of cast iron soil pipe and fittings. We would like to make cast iron steam fittings, but cannot use the same iron because there are little air or sand holes in the castings and furthermore, we require a much closer grain than for soil pipe. We do not care to go to the expense, if we can help it, of adding another 10 or 15-ton cupola, and would like to know of a good alloy to add to the iron in a reservoir ladle.

Answer.—Add one ounce of pure aluminum to every 100-pounds of molten iron and you will get rid of the air and sand holes. The aluminum can be obtained in coils of three-eighths-inch wire, and a piece about one inch long should be used for each 100 pounds of iron. By increasing the silicon in the mixture the same result can be accomplished. Powdered ferro-manganese will also help. You can, however, melt in the same cupola, a mixture exactly suited to your purpose. After you have charged all of the iron for soil pipe make the next coke charge a little larger and then charge the iron for steam fittings. You can easily judge when you should come to the new iron and the extra coke will make the melting a little slower, but somewhat hotter. By melting your soil pipe hotter you will get rid of the air holes.

ANALYSIS OF ENGLISH TEST BARS.

Question.—Have sent you four test bars from the first half and four from the last half of a heat. Please test them and send me the results. The first four tons have no hematite iron at all, while in the last four tons of the heat 150 pounds of hematite iron were added to each ton.

Answer.—The test shows very little difference. The average strength of the one-half-inch bars from the first half of the heat was 436 pounds, and from the last was 422 pounds. The shrinkage of the last was slightly greater than the first. The addition of the hematite was injurious. What you need is more silicon in your mixture.

CROOKED STOVE CASTINGS.

Question.—A large number of our stove plate castings come out of the sand crooked. How can this be avoided?

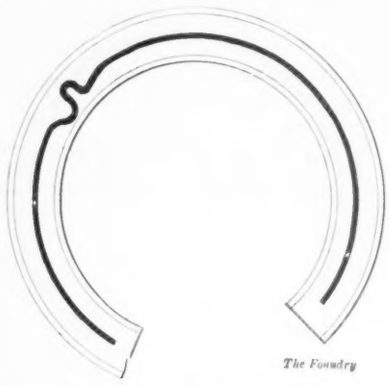
Answer.—By changing the gating of the pieces. Good molders will generally discover a way to make a casting straight if you discount the crooked castings they turn out. They will probably show you that your patterns are cambered the same way only less, and will refuse to take the loss. Be sure that your patterns are the same as you want your castings. Your foreman should be able to set the gates so as to bring each piece straight. Excessive shrinkage in the iron may cause the castings to be crooked. Increase your silicon until your castings come straight, as high as three per cent, if necessary. It requires skillful management to make straight stove plate, and crooked work is laid to the coke, iron and everything except to the lack of skill of the molder and foundry foreman.

EXPANSION OF A CORE WIRE.

Question.—The illustration presented herewith shows the peculiar action of a one-fourth-inch core wire. It was straight when put into the core of a fire pot ring for a hot water boiler and when it was taken out had the peculiar kink shown. Kindly inform me what caused this peculiar action.

Answer.—The core happened to be a trifle hard except at the point where the kink occurred, or the core may have been heated more in the casting at that point than elsewhere, on

account of a gate being close to it. At any rate the wire was cold when the hot metal filled the mold. The core and wire were heated nearly to the same temperature as the fluid iron and the wire was thereby increased in length and in this case the ends were not pushed into the core, but were held rigid. Other parts of the wire were also held fast by the core, except where the extra heat burned out



CORE WIRE SHOWING PECULIAR KINK

the binder of the core and softened it. This heat also made the wire flexible at that point and as it increased in length it doubled up at the hottest point.

HIGH SILICON.

Several days ago a chemist called on me and said: "You carry rather high silicon in your stove plate mixtures, do you not, about three per cent?" I informed him that 2.75 to three per cent silicon gave me the strongest castings, when very thin, as well as the closest grain, and iron as soft as required. He could not understand how high silicon could make strong castings, whether small or large. I then informed him that the following rules always applied: With low silicon, high shrinkage, and high strength of a one-half-inch square test bar, heavy castings will be strong, but small castings may be brittle and therefore weak. With high silicon, low shrinkage, and high strength of a one-half-inch square test bar, large castings will be weak and small castings will be strong.

WASH FOR STEEL CORES.

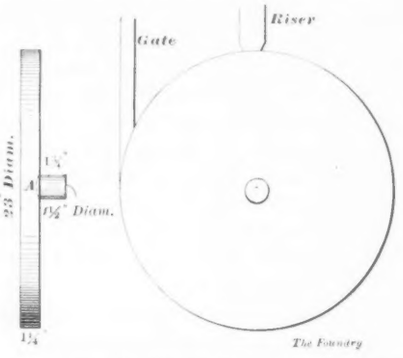
BY W. M. CARR

Question.—What is the best known composition and wash for cores for heavy steel castings? Sometimes our cores are all right and at other times are burned as hard as the steel itself.

Answer.—The best known composition is one that possesses the maximum degree of refractoriness and the minimum amount of bond. The refractoriness can be obtained through pure silica sand. The bond may be fire-clay, flour or core oils. The combination of silica sand and one or more of the bonds in proper proportions will give the best results. Careful experimenting will be the best guide. Too much fire-clay will have a tendency to make cores burn into castings. No more bond of the two other kinds should be used beyond the quantity required to give the cores a desirable stability when baked. Otherwise there will be "blows" through too much gas being generated when the castings are poured. Reliable brands of core oils or linseed oils give very good bonds, and with good sand the least trouble in burning into the castings. Such cores do not require any wash and will strip easily and cleanly. Satisfactory washes are prepared from finely pulverized silica or pure graphite.

VALVE CASTINGS.

Question.—We are having considerable trouble with gate-valve castings, as the shrinkage weakens the trunnions where they unite with the disks, as shown at A, Fig. 1, and they break off when supporting the weight. The disks are 23 inches in diameter and 1¼ inches thick, and have a trunnion 1½ inches in diameter and 1¾ inches long cast on the center. The disks have been molded in green sand, both flat and on edge. With the former method the trunnion was placed at the bottom and a riser used over the center of the disk, a feed rod being used in the riser to churn the metal. A riser was also tried on the edge of



FIGS. 1 AND 2—VALVE CASTING AND MOLD

the disk and the churning performed at the gate located at the opposite end of the diameter. The analysis of the iron in the disk made from a scrap mixture was as follows: Silicon, 1.74 per cent; sulphur, 0.13 per cent; phosphorus, 0.95 per cent; manganese, 0.45 per cent; combined carbon, 1.25 per cent.

Answer.—The shrinkage is caused by the trunnion cooling before the middle portion of the disk. The difficulty could be overcome in several different ways, and the one to try first will depend upon the local conditions. The iron mixture could be improved and some of the shrinkage prevented by the addition of some pig iron high in silicon. The trunnion could be prevented from cooling so quickly by using a riser directly on its end, or the central portion of the disk could be cooled more rapidly by using a chill in the mold at this location, or by uncovering this surface as soon as possible. The trunnion could also be cooled more slowly by casting it in a dry sand core, or the entire mold could be of dry sand and cast on edge as shown in Fig. 2.

F. W. B.

SANDLESS MOLDS FOR MALLEABLE CAST IRON.

BY DR. RICHARD MOLDENKE

The question often arises in the malleable shop whether this class of iron can be cast into iron molds and then annealed in the usual way. Here are the facts of tests made along this line. Some ten years ago, while making specialty work weighing some 300 pounds per casting, it was determined to try the sandless process. An iron mold was made, quite heavy and so arranged that it could be easily opened to remove the casting quickly. The castings being three feet long, and having a projection at one end, required the insertion of a core which could readily crush as the metal contracted. Until this was arranged the castings invariably came out pulled apart. After repeated failures, persistent work brought success and some 800 of the castings went out into actual service, and but for the deliberate ruining of the mold, it would have lasted a long while and readily made several thousand castings before repair.

As this will be of interest to the malleable fraternity, the following points observed will be of value. The heavy contraction found in white iron, half coming back in the anneal, necessitates close watch so that the iron may draw together evenly and without strains. Hence the use of cores where necessary, or the limitation of the method to straight work. Next it is necessary to heat up the mold to nearly dark red before cast-

ng. Then it should be filled as often s possible that it may be maintained t this temperature. The castings should be pried out at once when set, and covered with sand to cool slowly. Where metal is poured all day, as is the case in a malleable shop of heavy tonnage, a number of molds can be kept going and can be kept at the proper temperature, the metal cast into the molds at the start being used to heat up the molds. This was actually done in the case cited above, one or more castings being made for every heat during the day.

Now as to the metal. A number of tests made on the castings thus produced showed a tensile strength of some 38,000 pounds per square inch. This was about 2,000 pounds per square inch lower than the regular metal, and the abandonment of the method due to shop opposition caused the matter to rest there, for doubtless some way would have been found to correct this reduction in strength. Nevertheless, the metal made would be considered amply good enough for general purposes. It may therefore be said that where many castings are to be made, the making them in sandless molds has a great future and needs only intelligent application to be a success.

McADAMITE—A NEW ALLOY.

Described as the strongest light metal known, McAdamite seems to have some wonderful properties. Its specific gravity is nearly as low as that of aluminum, and it is considerably stronger, as the following table, compiled from tests made by Prof. Collins P. Bliss, director of the engineering department of the New York university, testifies:

	Tension. Pounds.	Compression. Pounds.	Transverse. Pounds.	Torsion. Pounds.	Spec. grav.
McAdamite	44,250	176,620	87,200	60,300	3.34
Cast aluminum	14,800	12,000	.....	.....	2.65
Naval bronze	31,550	78,000	31,986	44,300	8.76
Brass	29,300	53,000	34,530	38,000	8.90
Gun metal	32,500	.....	62,740	.....	8.50
Cast iron	21,000	91,000	38,400	.....	7.07
Copper (pure)	29,800	42,000	29,848	30,000	8.60
Tobin bronze	66,000	(cast)	.....	.....	....
Tobin bronze	79,600	(bars)	.....	.....	....
Manganese bronze	63,700	89,750	72,500	.....	....

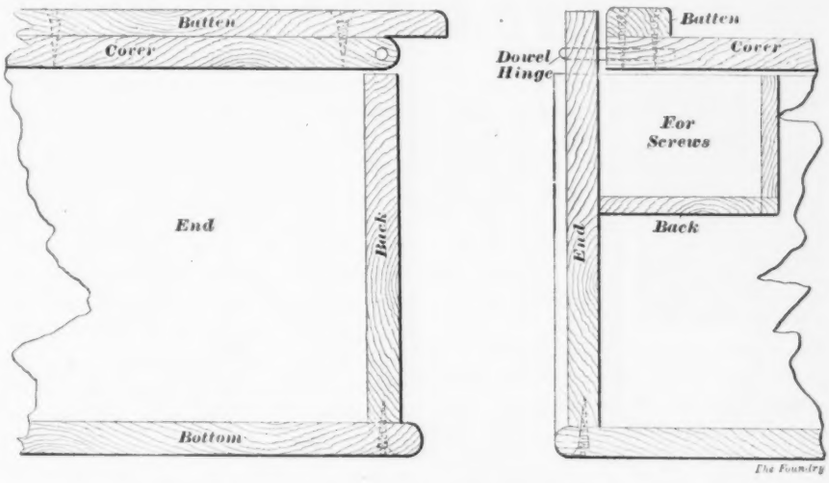
The alloy is manufactured by the United States McAdamite Metal Co., 18 Rapelye street, Brooklyn, N. Y., and is offered as a substitute for bronze and brass in many of the uses to which those metals are now put. It has two or three times their strength and three times their volume for the same weight, or one-third their weight for the same volume. It is claimed to be the first commercially practical metal of great strength and light weight for common uses. It has a fine color, is easily machined, and has a close grained structure. It melts at 977 degress Fahr. and pours well in molding, being very fluid and free from occluded gases. Gears and similar articles may be cast without subsequent machining. The surfaces of pieces cast from it have a bright silver-white appearance, and only a slight buffing is needed at the most. Where the alloy is used it is therefore possible to do away with much of the finishing of castings which is ordinarily necessary with common metals. The finest screw threads are readily cut in it, and its stiffness is remarkable as compared with bronzes and brasses. In many respects its characteristics are similar to those of cast steel of the best quality, and, weight for weight, it has equal strength in tension and greater strength in compression. For a cast metal its toughness and elasticity are very unusual, and the elastic limit when under compression runs so high (84,000 pounds per square inch) that it admits of a wide application.

TURNING TOOL BOX FOR PATTERNMAKERS.

I would like to call the attention of pattern shop foremen to a very handy and neat turning tool box that I saw in a shop some time ago. It seems to be the aim of every patternmaker to reduce the size of his tool chest, and he is either obliged to carry his turning tools in a small box provided for that purpose, or loose in a chest, which is very unhandy.

In this shop a small turning tool box was made for each bench, and every patternmaker was provided with one. A corner of this box is shown in the accompanying illustration. The dimensions are, of course, optional with the maker. These boxes had a small compartment at one end for screws, and when a face plate was removed, instead of throwing the screws away or in with the stock screws, they were put into the box, and it was surprising what a collection there was in some of them. The cover was secured to the box with a dowel pin through the end, as shown, and on top of the cover at each end a batten was placed to strengthen the cover. It also extended one inch over the cover at the back, and when the cover was open and in a vertical position, this batten extension touched the back, causing the cover to close except when held open by the hand. The object of this was to keep the box clean and free from shavings.

DAYTON JONES.



TURNING TOOL BOX FOR PATTERNMAKERS

REIGN OF THE CHEMIST.

Large works which have their own chemist will find it to their advantage to test their stores. A competent chemist should be able to advise on these matters as well as on the purity of metals.

A pewter-like appearance may be imparted to brass by boiling the castings in a cream of tartar solution containing a small amount of chloride of tin.

MOLDING A LARGE MACHINE FRAME

French System of Molding Large Standards by Machine—Ideal Layout—Special Swinging Machine

FOR molding machine frames and other large castings, a special inverting molding machine has been designed by Ph. Bonvillain and E. Ronceray, the French engineering firm which has recently introduced its universal system of machine molding to American foundrymen.

The sections are approximately 9 feet 10 inches long and 2 feet 8 inches wide, and the molds are without doubt the largest heretofore attempted on any machine. A plan view and section of the casting are shown in Fig. 8.

The swinging machine is used for making drags, while the cope parts of the molds are made on a standard type universal machine, Figs. 1 and 6. In the one view, the cope of the car wheel mold has just been lifted from the machine, while the ramming operation is shown in the other. When molding the machine frames, the table of the latter machine is, of course, much larger than shown herewith, and has a capacity for flasks 10 feet 4 inches long and 3 feet 2 inches wide. This table is of the composite type, and is made up of supports and pillars bolted to the foundation and can be adjusted to the shape of the pattern plates, and passages for stools and inside stripping plates are easily provided. The cross beam containing the ramming cylinder is connected with the base plate by two hooks while the sand is being rammed, and the ram itself is adjustable by means of a telescopic screw for reducing the consumption of water. The parting off arrangement is the same as that provided on the other standard types of machines built by this concern.

The swinging machine for molding the drags is shown in Figs. 2 and 3. The pattern plate with the flask after being filled with sand, together with the loose pressing plate, are pulled on to the table of the machine by means of a chain haulage arrangement. The pattern plate slides in machined grooves on the table of the machine. The flask and pattern plates are shown adjusted in Fig. 5. After the mold is rammed, the entire machine is inverted and assumes the position shown in Fig. 4. After the pressure is released, the mold rests on the loose pressing plate, and parts off from the pattern plate. The mold is then withdrawn from the machine on to a bottom board and may be placed

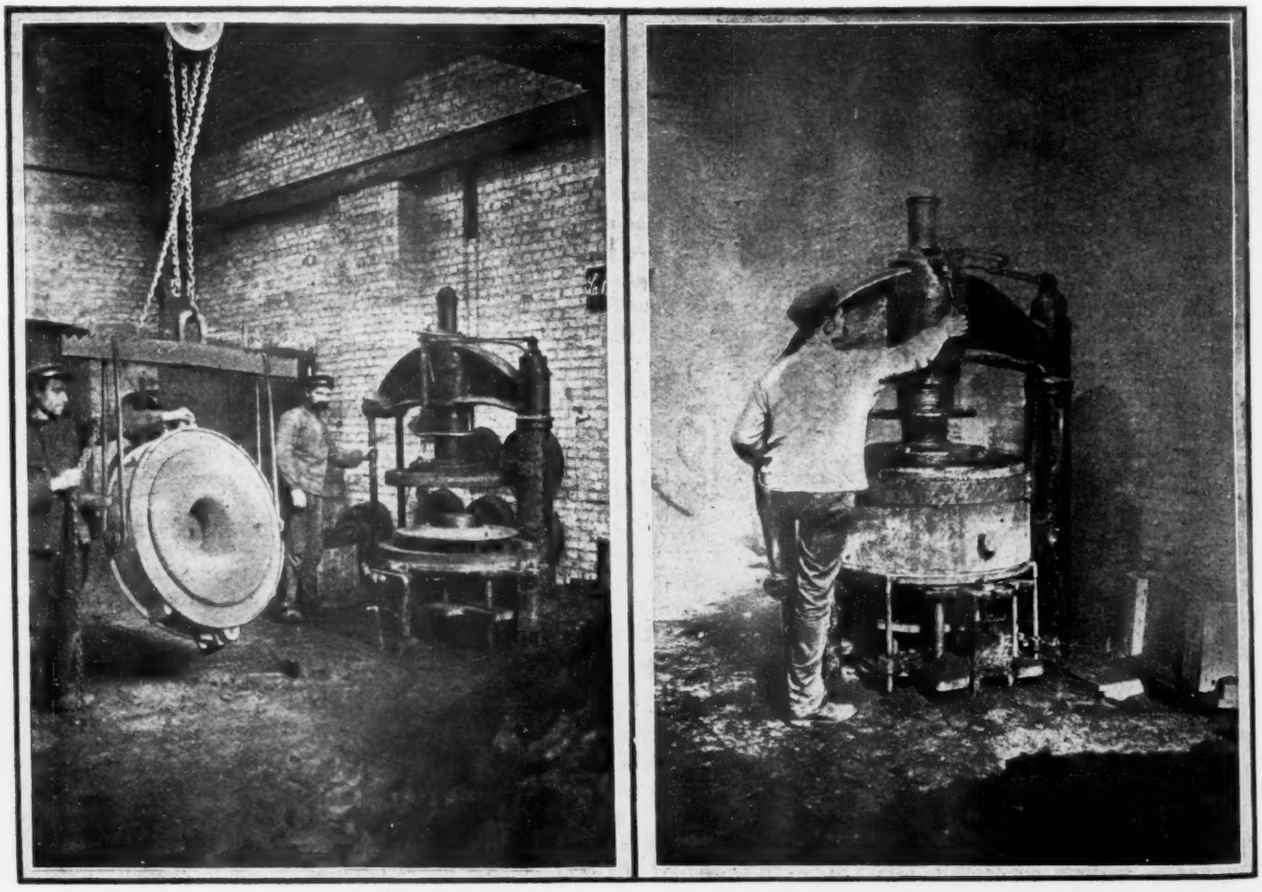


FIG. 1—COPE MACHINE MAKING CAR WHEEL MOLDS

on any part of the floor desired, by means of cranes. After the mold has been lifted off, the machine is turned over and to make a mold from another pattern, the pattern plate is pulled off the table, another flask and ramming plate adjusted and the operation repeated. The pattern plate, when the machine is being turned over to its normal position, is prevented from sliding out of the grooves by means of a pin in the table, clearly shown in Figs. 2 and 3, which is hydraulically operated.

The construction of the pattern plates is similar to that of those used on the revolving machines. When withdrawing the pattern or parting off, the stripping plate follows the mold a part of the stroke and obviates the breaking of the mold when leaving the pattern. These plates are prevented from following the mold for the full length of the downward stroke by the use of nuts, which may be conveniently adjusted. The whole pattern plate is mounted on a cast iron frame provided with lugs to slide in the grooves in the machine table.

A plan view of a plant arranged for the economical production of large molds on these machines is shown in Fig. 7. The swinging machine, R-M-3, is located at one end of the shop, and the cope machine, M-3, is placed at

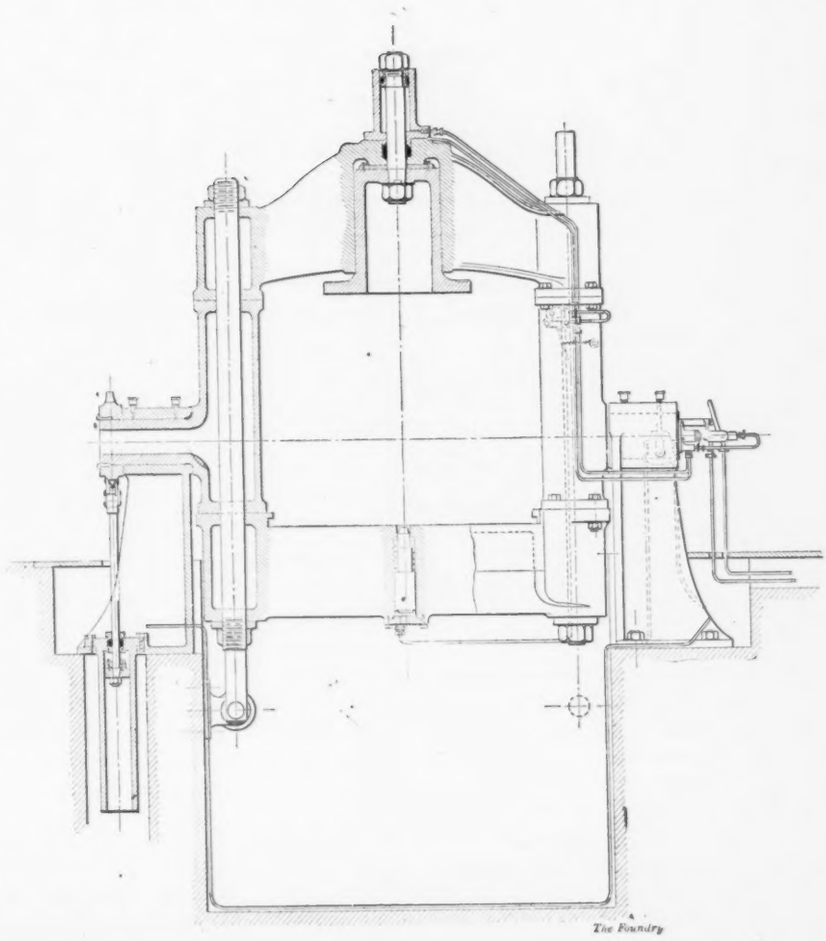


FIG. 2—SECTION OF SWINGING MACHINE ON WHICH THE DRAGS ARE MADE

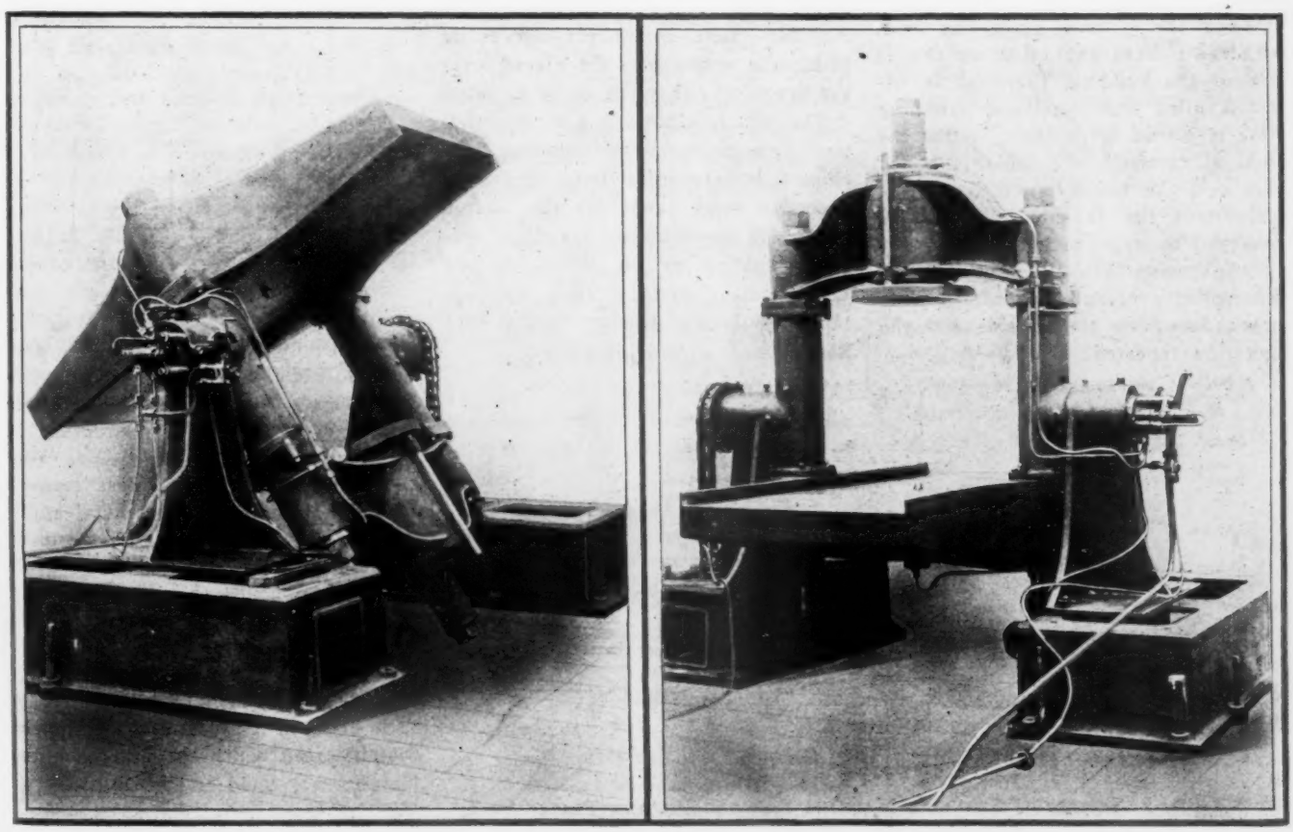


FIG. 3—SWINGING MACHINE ROLLED OVER—TABLE IN POSITION TO RECEIVE THE PATTERN PLATE

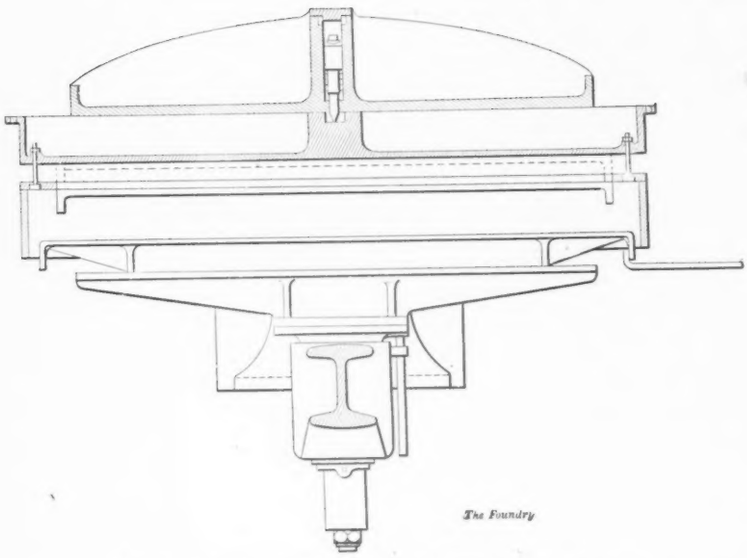


FIG. 4—SECTION OF SWINGING MACHINE ROLLED OVER

the other. The foundry is served by one electric crane, R-S, which commands the entire width of the building. Two smaller cranes, O P and 2 O 2 P, command the pouring floors, C and D, respectively, which are used alternately for storing the molds and pouring and shaking out the castings. While the pouring of the molds and shaking out proceeds on one floor, the newly made molds are being stored on the other. When the latter floor has been filled, the operation is reversed.

When the pattern plate has been withdrawn from the table on the D side of the building, the flask is adjusted, filled with sand and ramming plate is placed in position. After the mold is rammed, the table is rolled over and the mold is pulled off the table onto the D side, where it is conveyed to any portion of the floor by the crane O P. The machine is then rolled over and the pattern plate is withdrawn on the D side and the operation repeated.

When C floor has been filled with molds, they are poured, and D floor, from which all of the perviously poured castings have been removed, is cleared for the storage of molds. The pattern plate is then withdrawn on the C side, and the drag parts of the molds are handled by cranes 2 O 2 P.

While the swinging machine is making the drags, the cope machine, M-3, is making the copes, and the latter is served by the crane, R-S, which operates on a runway considerably above that of the other two cranes. As this crane commands the entire plant, the copes may be placed over the drags on either the D. or C. sides.

The E. H. Mumford Co., Philadelphia, manufacturer of molding machines, has recently been appointed exclusive sales agent for the United States for the universal system of machine molding by Ph. Bonvillain and E. Ronceray, Paris, France, who recently established headquarters at 1315 Race street, Philadelphia.

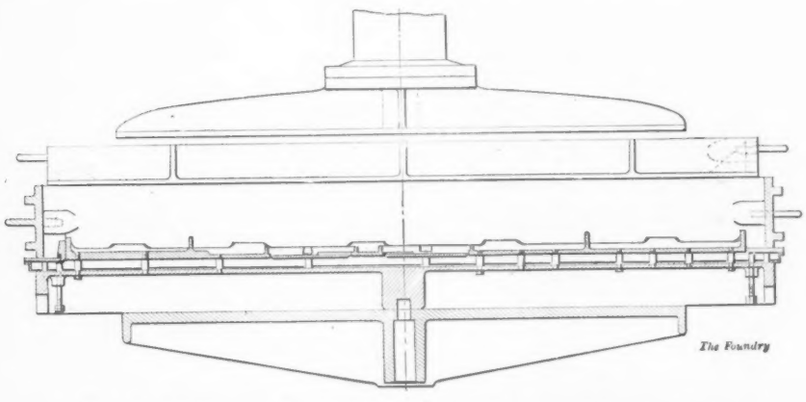


FIG. 5—SECTION OF SWINGING MACHINE SHOWING PATTERN PLATE AND FLASK IN POSITION

USE OF A HEATED FOUNDRY MIXER.*

BY J. B. NAU

In many places, where foundries are located convenient to blast furnaces, the idea of using direct metal from the furnaces, thereby eliminating all intermediate remelting processes with their attendant increased cost and defects in quality, has been carried out and is practiced today. The practice is naturally limited at least in this country to rough castings and cheap shapes, where the chemical composition and uniformity of metal are of less importance. In the finer grades of castings where more exacting requirements are the rule, the use of direct metal from the blast furnace is excluded, and in many cases, as in cast iron pipes for instance, the remelting of the metal in a cupola or an air furnace is prescribed by specifications.

One of the greatest objections to the use of direct metal is naturally its lack

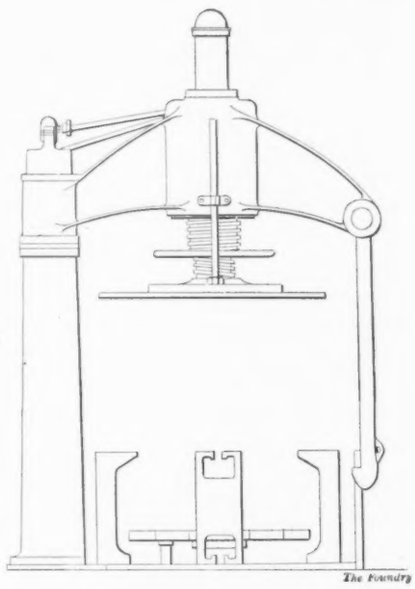


FIG. 6—COPE MACHINE

of uniformity, which is not always possible to obtain even in the most carefully managed blast furnace. Could this uniformity of metal be guaranteed at all times, there is no reason why direct metal from the blast furnace should not find a more general application. Surely nothing could be more economical. It was mainly to overcome this difficulty that at the meeting of the Foundrymen's Association, held in New York in June, 1905, the writer recommended the use of a heated mixer as a kind of an intermediary receptacle between the blast furnace and the foundry, into which the iron from the blast furnace could be poured.

*Presented at the Philadelphia Convention of, the American Foundrymen's Association.

Today I am in a position to state that the first step in this direction has been taken by our foundry and that other foundries also contemplate the adoption of a mixer.

Last year, the writer received instruction from the general manager of a blast furnace plant to design a mixer for the new foundry that the company is now building in that place, the name of which for the moment we are not at liberty to give. The foundry which will be a most modern one in every respect in the beginning will have a capacity of only 25 to 30 tons of very small castings, but ultimately, and in a very near future, its daily capacity is to be increased to fully 100 tons.

Owing to the limited output, a high priced tilting mixer with all its attendant operating and maintenance cost was out of the question. It was on the contrary decided to build a stationary furnace of the Siemens type with a short and deep hearth and air regenerators of a capacity considered sufficiently large for the temperature desired in the mixer. To avoid the operation of gas producers and the building of gas flues and valves, oil was adopted as fuel. The rated capacity of the mixer is only 25 tons or about sufficiently large to receive at one time all the iron that the foundry will require in a day's work in the beginning. On account of the very large number of small castings to be made the mixer will have to be tapped and stopped many times during the day.

If only one single tap-hole were laid in the lowest part of the hearth, the danger of metal breaking through between two taps would be great. In order to avoid this it was decided to adopt a certain number of tap holes laid at different levels and to draw from the upper tap hole all the metal that can be taken there before openening any tap hole lower down.

A mixer of a 25-ton capacity is however large enough to supply a foundry of 100-ton capacity and even more, the principal role of the mixer being to receive the direct metal from the furnace in large quantities during the day and while keeping it hot there and correcting its quality if necessary by suitable additions, withdraw it in repeated and smaller taps whenever required in the foundry.

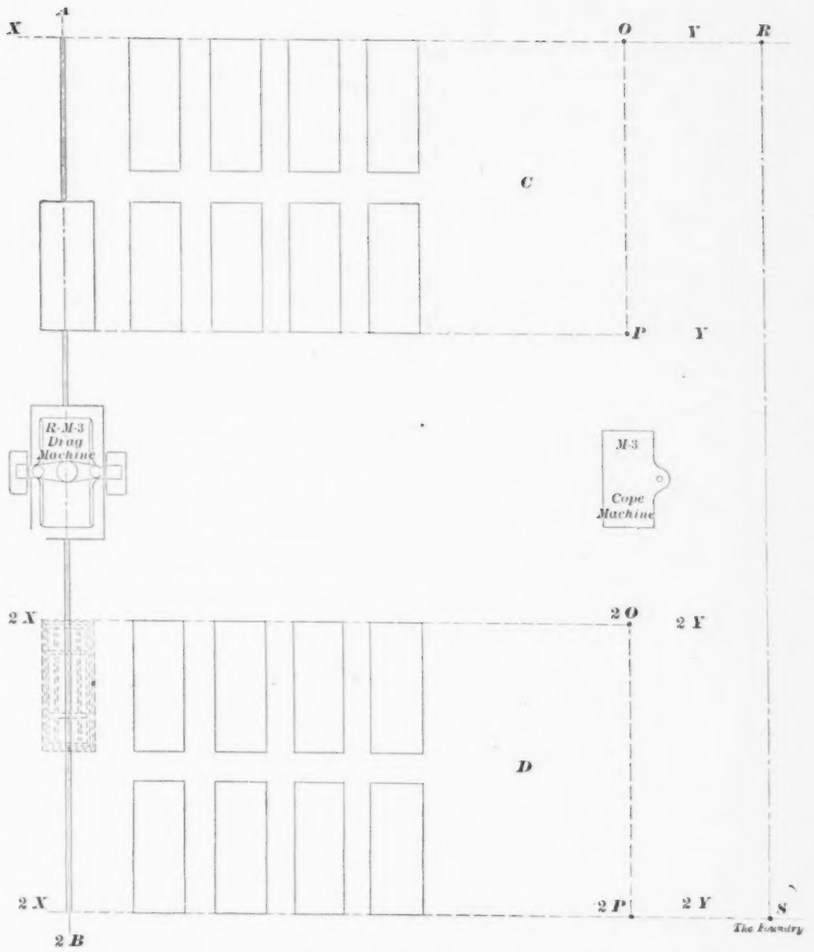


FIG. 7—IDEAL LAYOUT OF PLANT FOR MOLDING LARGE CASTINGS ON COPE AND DRAG MACHINES

The iron is brought from the furnace to the mixer in a ladle hung from an overhead trolley, thereby avoiding any interference with the yard track.

In large foundries where different grades of iron are used for different castings, the mixer again will be handy. In this case the direct iron from the blast furnace could be stored away in a primary mixer of larger capacity from which it could be tapped to feed two or three secondary mixers of smaller capacities. Each of these could supply one department of the foundry and with suitable additions of either pig or wrought iron scrap, the grade of iron required in that special department could be obtained accurately and with ease.

The mixer now building will not be in operation for some time. We can therefore submit no working data.

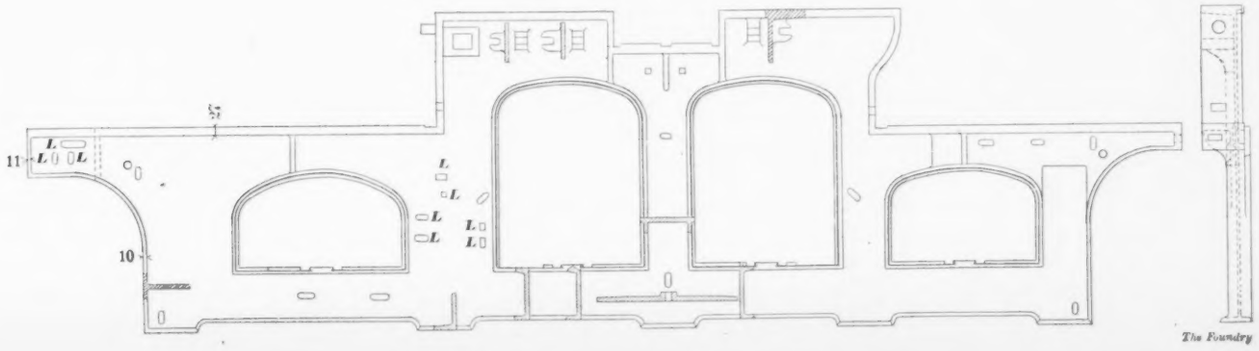


FIG. 8—PLAN VIEW AND CROSS SECTION OF THE CASTING

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Continuous Foundry Systems

The adaptation of the molding machine to the production of molds for every conceivable section has resulted in arousing interest among foundrymen in continuous operations. The molding machine is one of the most important links in a system whose success or failure not only hinges upon the rapidity of production, but the quality of the molds which are subjected to treatment that the ordinary molds left on the floor to be poured do not receive. The conveyor is another important factor that must be considered, as the loss of molds from vibration and sudden shocks is liable to offset the saving effected by the molding machine. The cost of the initial installation is heavy as compared with the floor system, and depreciation and repairs, as well as the interest on the investment, are factors of prime importance that should be given serious thought. Sufficient tonnage must at all times be assured to maintain operations at the maximum capacity, as a partial operation of the plant is out of the question. Foundries operating on specialties that are generally covered by yearly contracts are, therefore, better situated to adopt continuous methods than those that are dependent upon current orders, regardless of the similarity of the castings. While the malleable manufacturers are the recipients of large contracts from the implement makers from year to year for a class of goods that shows little variation, only a few continuous systems have been installed in these plants. This is undoubtedly due to the preference for the reverberatory furnace, which is not adaptable to continuous methods. The few plants that have adopted the system melt their iron in cupolas. The chief difficulty experienced by the car wheel makers is in securing machines that will serve their purpose. Several are being used, but the losses due to defective castings are said to be heavy, and the ponderous machinery required causes frequent interruption for repairs. Builders of sand handling machinery have designed conveyors and mixers that are practically automatic in operation, and the sand is tempered more uniformly than by hand. The main labor saving factors in semi-continuous systems are overhead trolleys, which serve each of the molding floors, delivering the metal from the cupolas and carrying the castings to the cleaning department.

Trade Outlook

There has been a slight improvement in the iron industry during the past month, and while buying has been limited, there has been no further recession in prices. Although generally admitted that a diminished tonnage must be expected during the winter months, the indications are that values will be maintained close to their present level. Offerings will be kept within the requirements of the trade, and the influences which prevented an undue rise during the boom will be exerted to counteract any tendency toward demoralization. In the west, charcoal iron is held at $27 Chicago for early delivery, and northern foundry, No. 2, at $23.50. In the Pittsburg district, Bessemer pig is still held nominally at $22.90, while basic is reported weak and can be had at $20.40. In the Birmingham district, as low as $18 is named for No. 2 for early shipment, although in the west consumers are displaying increased interest in future requirements. The level for No. 2 foundry, both at New York and Philadelphia is close to $20, and basic is selling as low as $18.75. Jobbing foundries, with few exceptions, report an increase in orders, and specialty shops—especially those engaged in the manufacture of small castings for agricultural implement makers—are closing large contracts for future needs. The sharp decline in copper is welcomed by the brass foundrymen who have suffered from abnormal prices for nearly a year. Old metals are also more plentiful and market conditions are again on practically a normal basis. Ferro-alloys continue high in price, although ferro-manganese is slightly lower and can be had at $53 per ton, Baltimore.

Letters from Our Readers

Having been practically buried by a deluge of commendatory letters since the publication of the September FOUNDRY, we are convinced that the change in the page area was a move in the right direction. The new size has made a decided hit. Below are extracts from a few of the many letters received:

From an advertiser—

"The new FOUNDRY has arrived like a new coon in town. It has certainly created a stir—in other words it is a corker. We have only one objection to make, and that is that it is now so large and contains so much matter that it takes too long a time to read and digest it. The time given to its columns will, however, be well spent, as the new stunts are worthy of careful consideration. We want to congratulate you upon the efforts that you are making to please the foundry trade."

From a subscriber—

"I wish to congratulate you upon the fine appearance of the enlarged FOUNDRY for September, just at hand. I have

watched its development from its birth to adolescence with great interest, and consider it unique among technical journals."

From another advertiser—

"We wish to compliment you upon the great improvement made in the September issue of THE FOUNDRY. We take this opportunity of assuring you that we appreciate the great effort that is being made to make this journal increasingly valuable to both advertisers and subscribers."

EXPERIMENTS WITH FERRO-SILICON.

To the Editor:—Referring to the discussion of "Ferro-alloys for Foundry Use" at the annual meeting of the British Foundrymen's Association, Prof. Turner, the celebrated English metallurgist, is reported to have said:

"Silicon also had been applied by Mr. Outerbridge for other purposes in the form of high silicon added to the ladle before casting. That was a new idea introduced in 1867 and widely applied. It was given up because ferro-silicon was so much more expensive than ordinary silicon."

This cannot be correct for the simple reason that the high grade ferro-silicon containing 50 per cent and upwards of silicon suitable for adding to ladles of molten iron after tapping from the cupola has only been made within recent years in an electric furnace at enormously high temperature and cannot be commercially produced in any other way.

In a paper on "The Beneficial Effects of Adding High Grade Ferro-Silicon to Cast Iron," which I contributed jointly and simultaneously to the American Society for Testing Materials and the American Foundrymen's Association, June, 1906, the following statement was made:

"In the year 1886 the author made many experiments in this direction, using the richest grades of ferro-silicon then obtainable, containing from 10 per cent up to 18 per cent of silicon, by adding the alloy in small lumps or in powder to ladles of molten iron, but found that the metal would not dissolve a sufficient quantity of the alloy to greatly change the proportion of silicon and thus to produce a marked increase in softness of the iron without appreciably affecting the temperature and fluidity of the molten iron. Preheating the alloy was the next logical step tried with an improved result, but it was soon ascertained that the inconvenience and cost of heating the alloy red hot would militate against its general usefulness. At the same time it was found that the addition of a small quantity of powdered ferro-manganese containing 80 per cent manganese (then a commercial product) accomplished the object sought in car wheel mixtures in a totally different manner by changing the condition of the carbon and without the necessity of heating the alloy. Therefore the tests with ferro-silicon were discontinued.

"In recent years electro-metallurgy has made giant strides and it is now possible to obtain commercially pure silicon (over 98 per cent pure) and ferro-silicon alloys of extreme richness, ranging from 50 to 80 per cent silicon or over. This fact caused the author to again take up the experiments of adding silicon to ladles of molten cast iron where he had left off in 1886."

I think it is probable that Prof. Turner was alluding to the experiments which I discontinued in 1887, since he had just referred to my more recent investigations.

ALEX. E. OUTERBRIDGE JR.

CYLINDER CASTINGS.

To the Editor.—The sulphur content of cylinder castings given by E. F. Lake, in the September FOUNDRY, is abnormally high. While a few of our castings have contained as high as 0.122 per cent of sulphur, they average 0.05 per cent. The phosphorus averages 0.52 to 0.58 per cent, although one analysis showed 1.21 per cent.

AUTOMOBILE.

PERSONAL.

Thomas Mitchell, superintendent of the Chester plant of the American Steel Foundries, has resigned to accept a position with the Reliance Steel Foundry Co., Delawanna, N. J. He has been with the American Steel Foundries for a number of years.

F. B. Maltby, who has been connected with the Panama canal work as chief assistant engineer to J. F. Stevens, has resigned and has been engaged in the capacity of chief engineer by Dodge & Day, engineers and constructors, of Philadelphia. Mr. Maltby is a graduate of the university of Illinois, and in 1907 received a degree from the same institution.

W. H. McFadden, of Mackintosh, Hemphill & Co., Pittsburg, sailed from Philadelphia on Aug. 31 for a three months' trip to Europe. Mr. McFadden has been in ill health since early spring and he will stay abroad until he recuperates.

E. T. Coe, treasurer of the Coe Brass Mfg. Co., Hartford, Conn., retired Sept. 1, having been connected with this concern for 40 years.

Robert B. Thompson, for a number of years superintendent of the Buffalo Forge Co.'s foundry, and recently foundry superintendent of the Abendroth Bros., has been appointed superintendent of the Reeves Foundry Co., Trenton, N. J.

OBITUARY.

John M. Stowell, Milwaukee, Wis., died August 30, aged 85 years. He was a native of New York and spent his early years on a farm. In 1856 he established in Milwaukee, a small machine shop for the manufacture of circular saws, and several years later formed a partnership with D. L. Filer, from which the extensive foundry and machine business of Filer, Stowell & Co. has developed. Mr. Stowell was formerly prominent in city affairs, and at one time served as mayor of Milwaukee.

Prespey Pero, founder and owner of the Pero Foundry, Worcester, Mass., died suddenly Sept. 1, aged 70 years. He was a native of Canada, but in his boyhood came to the United States, and after learning his trade, became foreman of the Smith & Page foundry, Fitchburg, Mass. In 1869 he established the business which he conducted up to his death. He was a member of the Perault family, most of whom, including several brothers prominent in the foundry trade, maintain the French spelling, but Mr. Pero preferred the abbreviated form.

WATERPROOF GLUE.

Waterproof glue is manufactured of gum shellac, three parts, and India rubber, one part, by weight, these constituents being dissolved in separate vessels in ether, free from alcohol, subject to a gentle heat. When thoroughly dissolved, the two solutions are mixed, and kept for some time in a vessel tightly sealed. This glue resists the action of water, both hot and cold, as well as most acids and alkalis. If the glue is thinned by the admixture of ether, and applied as a varnish to wood along the joints, it renders the joint water-tight and almost impossible to separate.—*Scientific American.*

FOUNDRY & PATTERN SHOP EQUIPMENT

Lifting Magnet—Adjustable Clamps—Diamond Core Oven—Snap Bench—Saw Filing Machine

THE NUMBER of commercial magnets actually in use in the United States today is relatively small, if consideration is taken of the great number of plants in this country which could use magnets for handling various forms of raw and finished metals entering into the products of their manufacture. This condition is doubtless largely due to the fact that the advantages of lifting magnets are not generally realized, and it is doubtful if any concern that has given the lifting magnet a fair trial has returned to the old method of handling iron and steel.

Wherever pig iron, metal plates, tubes, rails, beams, scrap or heavy iron and steel castings are to be handled, lifting magnets can be advantageously employed. The saving in time in adjusting hoisting tackle to the object to be raised is of itself oftentimes sufficient to justify the installation of a lifting magnet, while in the case of pig iron, plates, rails and scrap, the practical advantages of lifting magnets are still more obvious, owing to the large number of pieces that can be handled at a single lift and to the fact that the object to be handled need not be piled beforehand. A further advantage of lifting magnets is found in the fact that metal too hot to be handled by men can be taken care of as easily as cold metal by the magnet.

The design of a lifting magnet is varied to suit the metal, which it is required to handle. The construction of magnets for handling plates, or material of a similar nature, affording an opportunity to secure an intimate magnetic contact is a comparatively simple problem. Calculations as to the lifting capacity of such a magnet can be made with considerable accuracy as the total flux is easily figured. Magnets for handling billets, etc., laid in piles are, as a rule, operated in pairs, as such material usually comes in lengths up to 30 feet. They are most conveniently handled by two magnets placed 8 to 20 feet apart on a balancing bar to which the crane hook is attached. Magnets for handling pig iron, scrap, etc., present considerable difficulty in design, as they are expected to handle a wide range of material, varying in form, in magnetic permeability, and often encountered in irregular piles. This increases the reluctance of the magnetic circuit, and consequently, the total flux varies with each lift. This makes an accurate calculation of the flux almost impossible and renders experience essential to the production of a thoroughly good lifting magnet.

The most efficient magnet is usually considered the one which lifts in proportion to its own weight, the greatest possible amount of material. The weight of the magnet itself must be considered as dead weight, and the aim of the manufacturer is to construct a magnet that will combine the minimum of weight with the maximum of lifting capacity. Other things being equal, the larger the magnet the greater is its lifting capacity. While it is true that the weight of the magnet itself must be considered as dead weight, it may sometimes happen that the heavier magnet may actually be the more economical of the two. The material handled by lifting magnets is usually hoisted and then conveyed. The power required to hoist is directly proportional to the load on the crane hook, but this does not hold true in regard to conveyance, as the weight of the crane forms a large proportion of the total load to be moved. If a larger dead weight, by lifting more, enables the number of trips

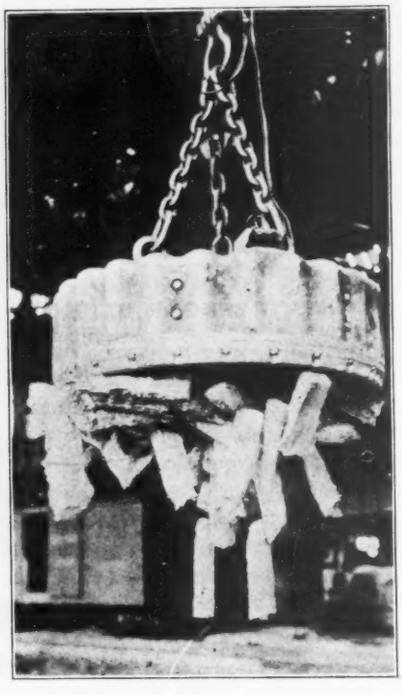


FIG. 1—THE LIFTING MAGNET AND 32 PIGS—WEIGHT 2,080 POUNDS

FIG. 2—LIFTING MAGNET HANDLING STEEL STAMPINGS

FIG. 3—MAGNET LIFTING 5,500-POUND SKULL

made by the crane to be reduced, a marked saving may be shown, both in time and current consumption.

The Cutler-Hammer Clutch Co., of Milwaukee, has recently placed on the market the electro-hoisting magnet shown herewith. This magnet contains features which, it is claimed, mark a distinct advance in the industry. A severe test undergone by one of these magnets comprised the unloading of a steel gondola car containing 109,350 pounds of sand cast pigs in two hours and five minutes. A 52-inch magnet was used and the work was accomplished by one man, the crane operator. The average lift of the Cutler-Hammer magnet was 785 pounds. In tests conducted with a similar magnet at the Donora works of the Carnegie Steel Co., 32 sand cast manganese pigs averaging 65 pounds each were lifted from the ground by this magnet, a total lift of 2,080 pounds. Under fair average conditions, a 50-inch magnet should handle from 1,000 to 2,000 pounds of material at a time, but this may fall to 500 pounds under adverse conditions or rise to 10,000 or even 20,000 pounds under extremely favorable conditions.

In the design of the Cutler-Hammer magnet the magnetic attraction of the inner pole has purposely been made stronger than that of the outer pole, the practical effect of this concentration of magnetic flux being that in handling pig iron or similar material the various pieces constituting the load are released by the outer pole first, when the current is switched off, and are drawn toward the center of the magnet by the superior attraction of the inner pole, thus enabling the operator to deposit the load within an area scarcely exceeding in radius the diameter of the magnet itself.

The following data were obtained during the test of the 52-inch magnet at the plant of the Youngstown Sheet & Tube Works above mentioned:

Total weight of pig iron unloaded	109,350 lbs.
Weight of average lift	739 lbs.
Number of trips required to unload gondola	139
Length of time current was on magnet	75 minutes
Time current was off magnet	50 minutes
Total time	125 minutes
Current required	30 amperes
Voltage	220

This gives a total power consumption of 8.25 kilowatt-hours, which, at a rate of three cents per kilowatt-hour, gives a total cost of current of less than 25 cents for energizing the magnet during the period required to unload 54 tons of pig iron.

This magnet possesses features which tend to give a high efficiency due to good proportioning of the magnetic circuit, insuring a deep penetration of the flux into the material to be lifted and largely to the attention given to the important question of heat radiation. The frame of the magnet is corrugated, which increases the surface available for radiation and, at the same time, forms niches that protect from injury the heads of the through bolts which fasten the removable pole piece, discussed later, to the magnet frame. Heat radiation is further aided by casting the magnet frame with a central aperture, through which air may freely circulate.

A point worthy of notice in connection with this magnet is the auxiliary pole piece. Lifting magnets of large size, designed for use with pig iron, scrap, etc., are made concave on the under side, because this form is best adapted to handling large numbers of irregularly shaped pieces of metal at a small lift. When, however, the load consists of one or two large objects with plane surfaces, this cavity becomes objectionable, as an air gap then intervenes between the inner pole and the object lifted. The central aperture in the magnet makes it possible to convert it in a few moments from a concave faced magnet into one adapted to handling large masses of metal with plane surfaces. This is accomplished by inserting in the central aperture an auxiliary pole piece proportioned to extend the inner pole downward to the level of the outer pole, eliminating the air gap and insuring intimate contact of both poles with the object to be lifted.

Another feature worthy of mention is the removable pole shoe bolted to the under side of the magnet by through bolts. This part of the magnet is subjected to the greatest wear, and in the present magnet may be easily renewed, reducing to a minimum the expense for repairs.

WESTERN FOUNDRY SUPPLY CO. EXPANDS.

The Western Foundry Supply Co. of East St. Louis, Ill., has outgrown its home at East St. Louis and just completed a new plant at Elizabethport, N. J., shown in the accompanying illustration. This company has recently purchased the ground ferro-manganese business of Crocker Bros. of New York, and has opened an office in the Phelps-Dodge building, known as 99 John street.

It grinds a general line of foundry facings, alloys and refractories at East St. Louis, consisting of plumbago, lead, talc, graphite, sea-coal, 80 per cent ferro-manganese, 50 per cent ferro-silicon, ferro-chrome, manganese oxide, fire clay, silica, oxide of chromium, etc.

The consumption of ferro-alloys among gray iron foundries has increased so rapidly, however, that the plant at Elizabethport, which has a capacity of 50 tons per day, will be devoted exclusively to the grinding of 80 per cent ferro-manganese, ferro-silicon and manganese oxide.

THE ELIZABETHPORT PLANT OF THE WESTERN FOUNDRY & SUPPLY CO.

The East St. Louis plant, which is really two plants with a power house between the two, is equipped with a 250-horsepower boiler, two 100-horsepower engines, three rock emery mills, three buhr mills, two rotary crushers, two roll jaw crushers, an impact pulverizer, two special mills for grinding metallic alloys and six 14-foot bolting reels.

The Elizabethport plant is equipped with a 150-horsepower boiler, 100-horsepower engine, two roll jaw crushers, two impact pulverizers, two mills and a duplicate set of screens.

W. G. Nixon, of St. Louis, formerly purchasing agent of the Missouri Pacific Railways, is in charge of the East St.

Louis plant and J. A. Rogers, formerly of St. Louis, is in charge of the New York office and the Elizabethport plant, which began grinding July 4, 1907.

Having two plants, puts this company in an excellent position to make prompt delivery of ferro-alloys to any part of the United States.

THOMPSON ADJUSTABLE CLAMPS.

While the introduction of molding machines has greatly increased the output of specialty shops and has reduced the cost of manufacture, jobbing foundry methods are very much the same as they were 30 or 40 years ago, and the jobbing foundrymen are earnestly seeking devices that will reduce their costs in the same ratio as has been done in specialty shops.

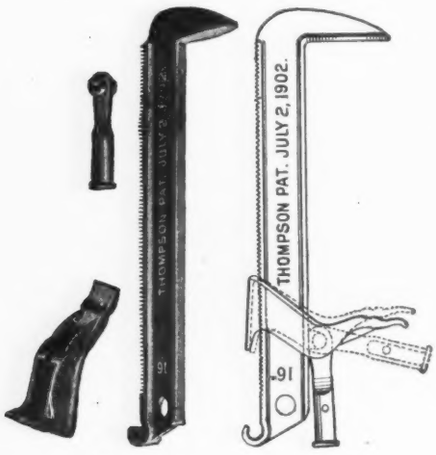


FIG. 1—THOMPSON CLAMP

While the manufacturers of molding machines are making efforts to devise machines that can be readily adjusted to the various needs of the jobbing foundry, the foundryman must give the smaller items of cost which enter into his daily production and ascertain where a possible reduction of cost may be effected.

A successful foundryman will endeavor to have his equipment applicable or quickly adjustable to the various conditions which daily confront him.

None of the tools in the foundry are used more frequently than flask clamps, and for this reason a clamp that will serve a great many purposes and will obviate the necessity of the operator hunting for a certain size will in a short time affect a considerable saving.

The adjustable clamp shown herewith was designed by A. M. Thompson, of the Link Belt Co., Chicago, for the purpose of overcoming the annoyance and delay occurring daily in the foundry on account of the lack of suitable clamps.

While many tons of cast iron clamps are a part of the equipment of every foundry, it often happens that the sizes wanted are already in use and the molders spend a great deal of time hunting up something suitable for these molds, much time being lost which might otherwise be devoted to the making of molds.

Fig. 1 is a detailed view of the clamp, and the dotted lines show the movement of the toe, which is forced down by the lever and quickly clamps the flask. The adjustment is accomplished by the notches on the back of the clamp, firmly holding the toe in whatever position the top of the flask allows it to come.

Fig. 2 shows a flask 36 inches high clamped with 42-inch clamps, and it will be readily seen that if the flask should be 30 inches high or less, the same clamps could be used. To secure the chaplets which hold the core in position the clamp is laid on the chaplet and the toe pushed up to the side of the flask, and when the lever is pushed forward the clamp will be sufficiently tight to prevent the core from rising.

Fig. 3 shows four drags clamped together to form a check for pulley mold. The flask is suspended by the upper piece which shows the rigidity of the clamps.

Fig. 4 shows how the column of a modern foundry may serve a useful purpose. The shelf is made of cast iron, 35 inches in diameter and ⅜ inch thick, split with cores to permit it to be hung on the column. It forms a convenient receptacle for brushes, gate pins, nails, patterns, tool boxes, blacking bags, bellows, riddles, etc., which accumulate on the molder's floor and serves to give the foundry a neater appearance.

The adjustable clamps are made to hang on the rim of this shelf. The shelf requires little space and is always convenient to the molder's floor.

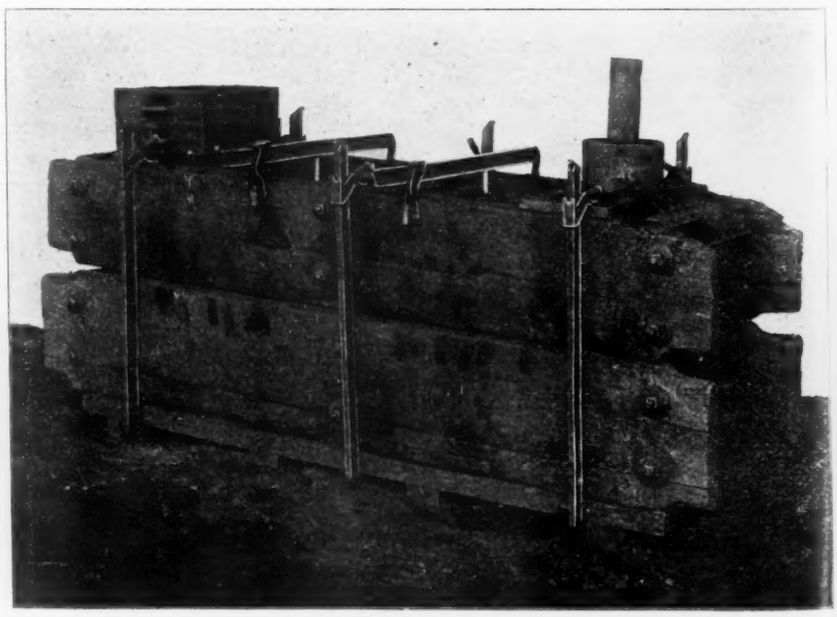


FIG. 2—LARGE FLASK CLOSED WITH THOMPSON CLAMPS

VENTILATION OF FOUNDRIES.

Modern systems of heating and ventilation can be equally well adapted for cooling foundries in the summer time, as well as heating them during the winter months. Much time is lost in summer in many foundries owing to the extreme heat, but this can be readily overcome by filling the coils with cold water and projecting cold air through the pipes which carry the warm air during the colder months. The American Blower Co., Detroit, has given this subject considerable attention and in many foundries where this company's system has been installed, practically no time has been lost during the recent heated season, as the shops have been kept at a temperature considerably below that prevailing outside.

TRADE NOTES.

The pig iron, coal and coke business heretofore conducted under the firm name of Elliott, Debevoise & Anderson, 95 Liberty street, New York, has been incorporated as the

Debevoise-Anderson Co., with a capital of $25,000, with Niles Anderson as president and Paul Debevoise secretary and treasurer. The business was inaugurated in December, 1905.

The Northern Engineering Works, Detroit, has furnished the Penna. R. R. Co. two 12½-ton 3-motor electric traveling cranes for installation in the Altoona, Pa., shops.

Several large orders for the 20th Century molding machine manufactured by J. F. Webb, Elkhart, Ind., have recently been booked by the J. F. McCormick Co., Pittsburg, exclusive selling agents.

The Waterbury Castings Co., which is erecting a new foundry at Waterbury, Conn., has contracted with the General Pneumatic Tool Co., Montour Falls, N. Y., for the necessary equipment of Shepard cranes. These will be of 50-foot span, to cover the main bay, and will be of five-ton and ten-ton capacity.

William Gregory has been placed in charge of an office recently opened in the Singer building, 149 Broadway, New York, by the East Buffalo Iron Works of Farrar & Trefts. Mr. Gregory is a man of experience in all departments of iron and brass foundry work.

The Robins Conveying Belt Co., which heretofore has maintained its general offices at 13 Park Row, New York, is moving them to Passaic, N. J., where its manufacturing plant is located. A New York sales office will be continued.

The Rock Island-Frisco railroad system has compiled a very interesting map showing the factors of prosperity in the Rock Island-Frisco states of America. The map has been published by the passenger department of these two roads and can be had by addressing John Sebastian, passenger traffic manager, Chicago and St. Louis.

The S. Obermayer Co., Cincinnati, manufacturer of foundry supplies, reports a continued heavy demand for its National Iron Filler Cement. This product is sold in a powdered form, and when required for use is mixed with water to the consistency of stiff putty. It can then be pressed into the crack or crevice in the casting to be prepared.

The Northern Engineering Works, Detroit, has installed a 3-motor electric traveling crane in the plant of the Vulcan Iron Works, Winnipeg, Manitoba, and has furnished the Erie City Iron Works, Erie, a 15-ton hand power crane.

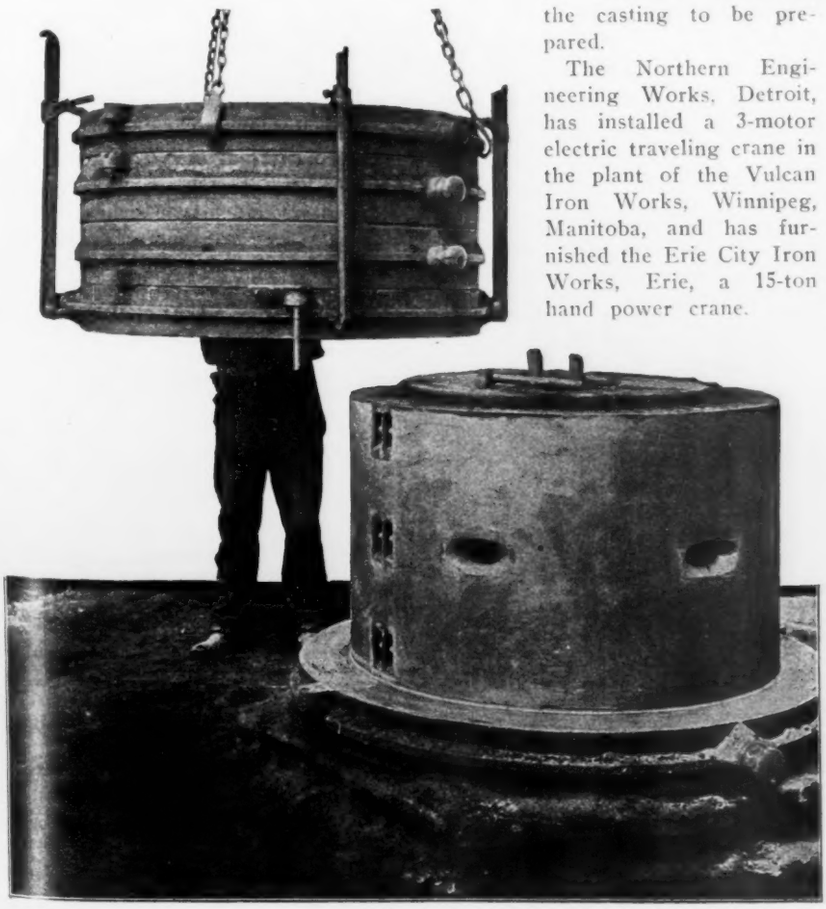


FIG. 3—FOUR DRAGS CLAMPED TOGETHER

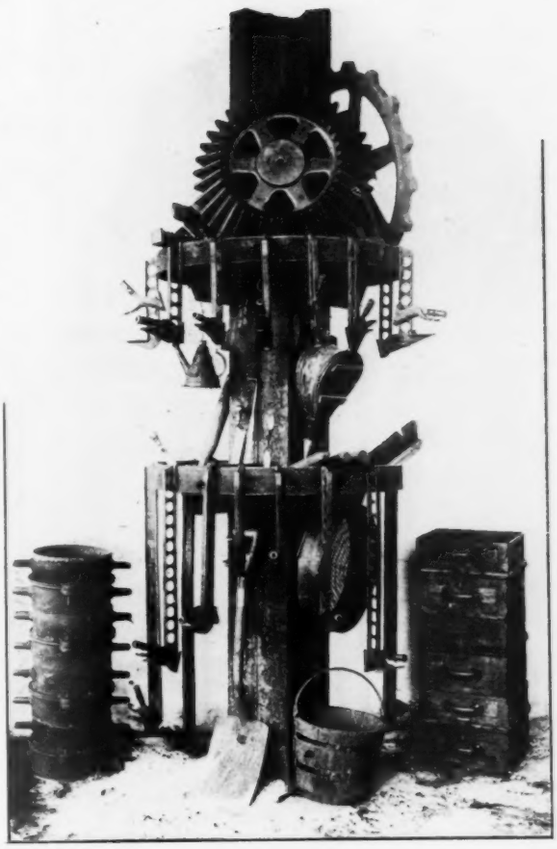


FIG. 4—SHELF FOR CLAMPS

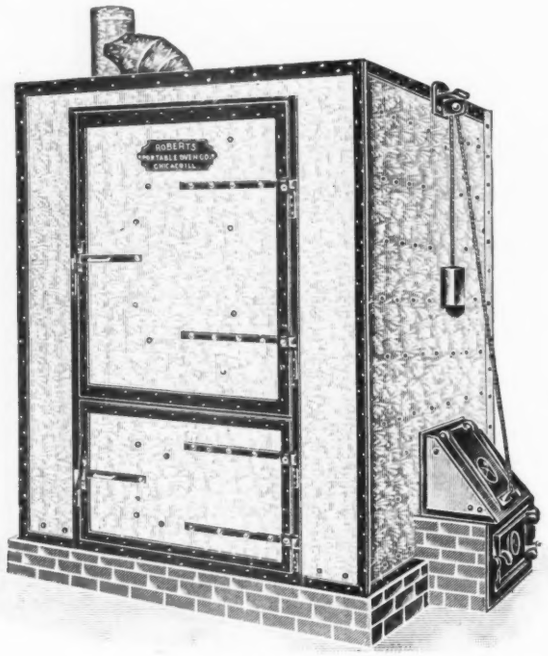
THE BLACK DIAMOND CORE OVEN.

The core oven shown in the accompanying illustration is designed to take the place of one of brick construction, and can also replace a small oven for foundry work. Doors are attached to both the back and front, practically doubling its capacity for small cores. The walls are from 2 to 3 inches in thickness, according to the size of the oven, and are packed between braces with mineral wool in such a way that the wool can not sag. The front of the oven is fitted with two doors, the upper one being about 3 x 3 feet, and the lower than 3 feet x 1 foot, 10 inches, and the latter can be used when inserting ladles for drying. The bar that separates these doors can be removed by taking out a bolt at each end, so that the whole front of the oven can be thrown open when necessary. The back of the oven is fitted with one door 3 x 3 feet, and in this way both the back and front can be used, thus practically giving the oven a double capacity for small cores. The racks or shelves are made of iron pipe from ¾ to 1 inch in diameter, and are set 6 inches apart each way. These pipes are removable, as the ends merely fit in round sockets attached

to the angle irons, which in turn are attached to the sides of the oven. These in turn rest on the foundation on which the oven stands, and in this way the weight of the cores is not carried on the sides of the oven.

The ovens are shipped in sections and are assembled by bolting the corners, and by the use of furnace cement the joints can be made perfectly tight. The inside sections of the oven are made of heavy sheet steel with galvanized iron outside. The furnace is not furnished with the oven, but can be made of fire brick by the foundryman. The castings for the furnace and ash pit doors, as well as the frame work for the furnace front are shipped with the oven. The flue pipe is attached to the outside of both the top and lower part of the side of the oven opposite the furnace, and the connections have a slide damper that the heat from the furnace may be drawn across the oven to the lower opening, or the lower opening can be closed and the upper one opened, thereby conveying the heat to the upper part of the oven. The foundations of these ovens should consist of three courses of ordinary brick. The grates are of the ordinary straight bar pattern, which can be made in every foundry. The amount of coal or coke necessary for heating the oven it is claimed is very small.

This description applies to ovens from 4 to 6 feet square, but these dimensions can be modified as required. The oven is manufactured by the Roberts Portable Oven Co., 73 to 81 East Erie street, Chicago.



DIAMOND CORE OVEN

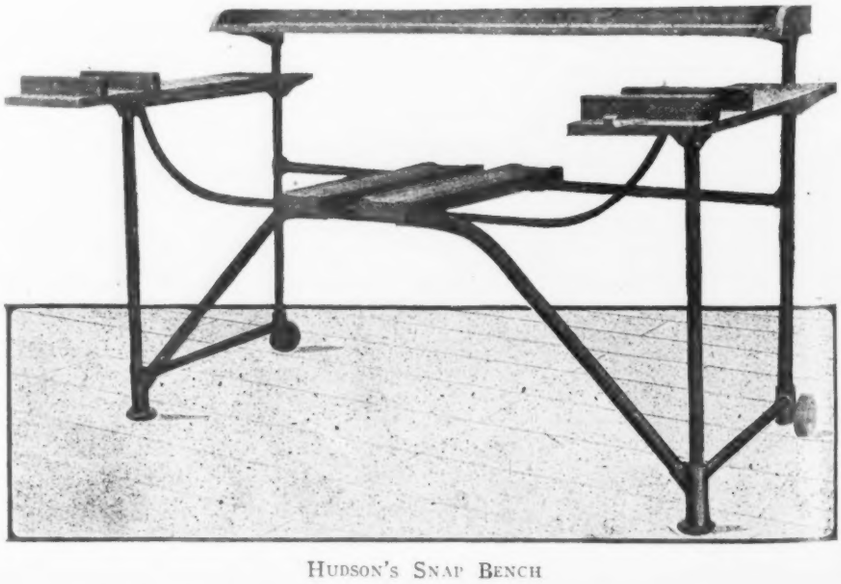
HUDSON'S SNAP BENCH.

The snap bench shown in the accompanying illustration has been designed by J. M. Hudson, secretary and treasurer of the Piqua Flour Co., Piqua, O. The frame is built entirely of steel tubing and malleable iron castings and the shelves are made of selected lumber. The two center boards on which the molder fills and rams his flasks are provided with four iron strips, each 1¼ inches wide, that prevent the boards wearing off round.

The bench is portable, being provided with two wheels attached to the rear frame, and can be moved to any part of the foundry floor by one man. It is also constructed to conveniently straddle the sand heap, and a single molder can work up the heap on a long floor without the assistance of a helper or another molder to move his bench. Nor is he compelled to remove any of his tools as the top shelf is 12 inches wide and 68 inches long, and provides ample room for his tools and prevents their rolling off when the bench is moved.

The frame is constructed without the use of bolts, nuts, screws or nails, the tubing being threaded and is securely fastened to the castings and fittings, insuring strength and rigidity.

The working space provided the molder inside the two side shelves is 56 inches which gives the operator ample room even though he is working with a large flask. By the use of this bench it is estimated that the molder's output will be increased at least 10 per cent. The bench is built by J. M. Hudson, Piqua, O.



HUDSON'S SNAP BENCH

THE FOLEY BAND SAW FILING MACHINE.

In the accompanying illustrations we show the Foley band saw filing machine for which the Cleveland Fillet Co., 1444 E. 49th street, Cleveland, is agent. This is without doubt one of the most perfect devices for filing band saws under two inches in width that has ever been placed on the market. Its principal features are simplicity, accuracy of cutting and speed. The movement of the file is accurate

nd uniform and the machine is positive in action.

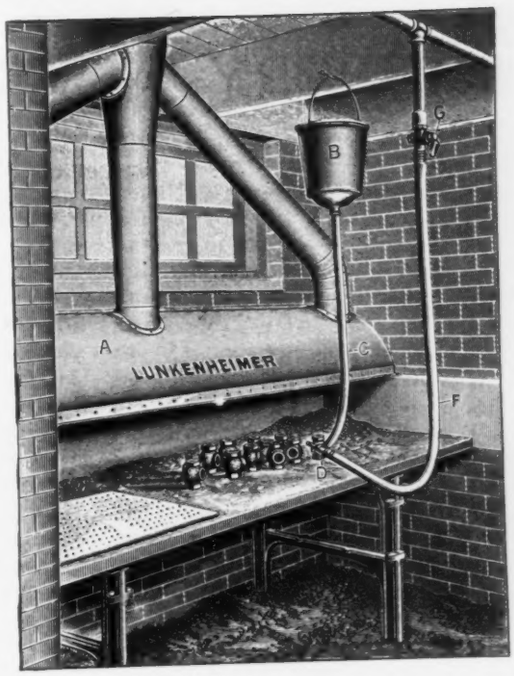
A slide is carried in two guideways, being actuated by a crank and pin working in a slot, the crank being driven from the driving pulleys. The adjustment of the machine is simple and it can be made to accommodate any size or shape of tool. Any style of file may be used, from a 6½-inch to an 8-inch file, either blunt or tapered. The file may be adjusted to any angle. The machine has few wearing parts and wear may be easily taken up. An important feature to which the maker calls attention is the impossibility of filings falling into any of the wearing parts.

The machine operates automatically, after being once started, and can be driven either by hand or power, a tight or loose pulley being provided. A feature of the machine is that it not only sharpens but joints the teeth as well. As an indication of its speed an 18-foot saw in any width from the narrowest up to 2 inches may be filed by this machine in ten minutes. The machine is sold under a guarantee for two years, covering breakage on account of defective material or wear from ordinary use. This tool has been on the market about six months, but the demand for it is extremely active and the manufacturer is behind on orders.

LUNKENHEIMER SAND BLAST NOZZLES.

Although particularly adapted for cleaning castings, the Lunkenheimer sand blast nozzles can be used for removing paint or stain from wood and metal, frosting glass and for imparting a particularly fine luster to metals.

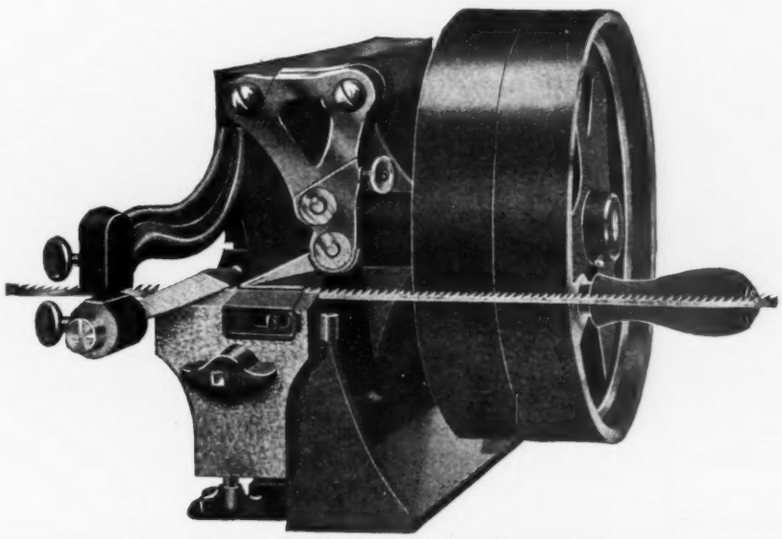
A sand blast room equipped with one of these nozzles is shown in the accompanying illustration. A hood A is arranged slightly above the bench on which the cleaning done, to which a suction pipe is connected which carries off the dust and dirt that would otherwise accumulate. The sand that is carried off through the suction pipe can be used over again. Suspended from the ceiling is a reservoir B for the fine sand used. It is connected by a flexible hose C to the nozzle D to which the sand is fed by gravity. Connected with the removable tailpiece of the nozzle is a hose leading from the air supply. A valve is provided for regulating the flow of air.



LUNKENHEIMER SAND BLAST NOZZLE IN CLEANING ROOM

The design of the nozzle is the result of considerable experimenting, difficulty having been experienced with the wear on the outlet tube. This has, however, been overcome by the use of a hard composition of which the tubes are now made. The air tube is contracted at one end which gives additional force to the blast and reduces the air consumption. The body, tailpiece and the union are made of a hard, high grade bronze. The outlet tube and the air tube can be readily renewed when worn.

To obtain the best results from 60 to 100 pounds air pressure should be used and the tubes H and J should be regulated to suit the pressure. This can be easily accomplished as the tubes are merely held in place by set screws. The higher the pressure the closer the tubes should be placed together. The nozzles are manufactured by the Lunkenheimer Co., Cincinnati.



FOLEY BAND SAW FILING MACHINE

TRADE PUBLICATIONS.

AIR COMPRESSORS.—The American Air Compressor Works, 26 Cortlandt Street, New York. Bulletin No. 18 illustrates and describes box bed plate compressors and vacuum pumps. This concern manufactures many other styles, sizes and types not shown.

PATTERN SHOP AND FOUNDRY SUPPLIES.—Shanafelt Mfg. Co., Canton, O. Twenty-page catalog. This booklet is handsomely illustrated and contains descriptions of the leather and wood fillet made by this company as well as pattern shop letters and figures, fillet tools, rapping plates, dowels, pinch dogs, corrugated fasteners, etc. A complete line of chaplets is also shown adaptable to all foundry requirements. Several pages are also devoted to a description of the steel cement manufactured by this company, as well as its casting brushes, pulleys, etc.

INJECTORS.—Hayden & Derby Mfg. Co., New York. Fifty-two page catalog. Describes and illustrates the Metropolitan injectors, ejectors and jet apparatus made by this concern.

FOUNDRY COST RECORDS.—James C. Loughry, Elyria, O. Six-page pamphlet. Describes the set of practical foundry cost records compiled by Mr. Loughry, who is a practical foundry accountant.

PYROMETERS. — Chas. Englehard, 41 Cortlandt street, New York. 56-page catalog. Describes the LeChatelier Pyrometer sold by Charles Englehard. This is the fifteenth edition of this work which gives much interesting data regarding the melting points of metals, etc.

FOUNDRY ASSOCIATIONS AND SOCIETIES

September Meetings of the Philadelphia, New England and Pittsburg Bodies—Foundry Foremen

THE FIRST meeting of the Philadelphia Foundrymen's Association since the summer was held in the evening of Sept. 4 at the Manufacturers' Club, when H. L. Haldeman presided in the absence of President Thomas Devlin. The feature of the evening was a pictorial description of the universal system of machine molding of Messrs. Ph. Bonvillain & E. Ronceray by the use of the ordinary stereopticon and the cinamatograph.

The paper was announced as by Monsieur E. Ronceray and was in every sense his work, but at his request the description of the illustrations and the remarks about the machines were made by E. H. Mumford, of the E. H. Mumford Co., which has undertaken the American agency for the sale of these machines, in addition to its own.

The ordinary lantern slides were first used for purposes of description, and the operation of the machines was then shown by the cinamatograph views, which made the working of the machines almost as vivid as if observed in actual work at the foundry.

Beginning with group views of skeleton outlines of the machines, it was shown that six sizes of the French machines covered the entire range of molding sizes, from the smallest to molds 4 feet x 5 feet 6 inches and 3 feet 6 inches x 10 feet.

The standard machines, operating with water at 750 pounds pressure per square inch in a manner similar to the American compressed air machines, were shown to have freely adjustable pattern drawing apparatus, which can be set in a few minutes' time to any size or shape of flask within the ramming capacity of the over-hung hydraulic cylinder on the machine. The fact that with each change of patterns there is brought to the machine the apparatus which contains the center line for the pattern match and the flask pins entirely independent of the machine itself, illustrated the flexibility of the French system and the comparative simplicity of the machines.

It was shown that on these machines the plunger which draws the patterns is also used to compress from the under side pockets of deep sand without loss of time, and the speed of pattern draft was shown to be entirely within the control of the operator. In the rotary or inverting machines, it was seen that the ramming plunger descending from above in the first operation of the machine immediately becomes a clamp, holding everything together, while the machine is inverted, and then, in the inverted position, becomes the pattern drawing mechanism simply by the exhaust of the pressure water, so lowering the finished mold from the over-hung pattern, the pattern drawing and double ramming plunger, now on top, following deep green sand parts during the early part of the descent of the mold.

It was shown that on the largest machines there is simply a floor plate, on which supports for flask and patterns are placed in any convenient positions, on the same principles as in the smaller machines used in molding. The simplicity of the hydraulic machinery was illustrated, and it was explained that the power consumption is less than one-quarter what it is with compressed air, considering the question from the delivery of the pressure generator to the number of finished molds of a given size.

The novel methods used in making hard, non-shrinkable, white metal patterns and stripping plates were fully illustrated and described, and stripping plate patterns and "Cliches" were exhibited at the meeting.

Among the exhibits was a flask containing six 1¼-inch gate valve bodies, the patterns and stripping plate for which had been made complete, ready for work, in three days by one molder, who had only a single half wooden pattern to work from, and this not a master pattern.

The general statement was made that stripping plate patterns made by the French process cost about one-sixth what they cost in iron as known in America today, even with edges babbitted, and it is clear from the casting methods used that the more intricate the pattern work, the greater the economy of the French process.

The fact is that the French process of pattern-making furnishes the foundry with foundry jigs, which jigs are the only thing supplied to the foundry by the machine shop; the foundry is absolutely independent of both machine shop and pattern shop in the supply of its pattern equipment. Moreover, these foundry jigs used for the production of reversible or non-reversible patterns give more accurate results than are possible without the greatest skill and care by machine jig processes.

With the foundry independent as to its patterns and with stripping plate machines having no relation to pattern match simpler and costing less than machines which have, so that the foundryman can supply himself with molding machines and patterns in a way that has never been possible for him before, it would seem that machine molding comes nearer the foundry ideal than ever.

A brief discussion of trade conditions followed, in which several members stated that there had, as yet, been no recession in business with them, but that they anticipated it in the near future.

Previous to Mr. Mumford's talk a report was made on the winding up of affairs of the recent annual convention of the American Foundrymen's Association, in which the very gratifying statement was made that over $9,000 had been collected for the entertainment of visitors and that less than half of this had been spent, so that there remained for contributors a dividend of 50.08 per cent of their subscriptions, which had been returned to them. Marshall Cushing made an address on the project for enlarging the usefulness of the Manufacturers' Club by erecting a new building and extending its scope at a cost of $2,000,000. Mr. Cushing also spoke very hopefully regarding the future prospects of the business world and said there is no reason to be alarmed by the present condition of affairs.

PITTSBURG FOUNDRYMEN'S ASSOCIATION.

The first fall meeting of the Pittsburg Foundrymen's Association was held in the banquet room of Hotel Henry, Pittsburg, Monday evening, September 9. Mr. Elliot A. Kebler, of

Mathew, Addy & Co., read a paper on "Selling for the Foundry," advocating a better cost system for foundries, a closer check between original estimates and actual costs, and the elimination of guess work. W. B. Robinson, of the Pittsburg office of *The Iron Trade Review*, read a paper on "Publicity," pointing out the value of trade papers both as a buying and selling agency and as a corrective influence. Thos. D. West and Dr. Richard Moldenke were unanimously elected honorary members of the association, and the Pittsburg Malleable Iron Co. was elected to membership. A new membership committee consisting of H. E. Field, E. D. Frohman and Elliot A. Kebler was appointed. The annual election of officers will take place at the next meeting, the first Monday in October.

NEW ENGLAND FOUNDRYMEN.

The New England Foundrymen's Association, after successful outings during the summer, resumed its regular monthly meetings at the Exchange Club, Boston, on Sept. 11.

The Atwood-Morrison Co., Stonington, Conn., was elected to membership. A rising vote of thanks was extended to Providence members of the association for the delightful program provided at the August outing.

The president reported the deaths of A. F. Nichols, of Nichols Foundry Co., Lowell, Mass., and D. B. Lincoln, of Wollaston Foundry Co., Wollaston, Mass. The chair appointed Messrs. Doherty and Lanigan as a committee to prepare resolutions anent the death of Mr. Nichols, and Messrs. Carpenter, Nutter and Fitch as a committee on Mr. Lincoln.

The meeting then adjourned to dinner, after which the chairman introduced C. H. Bradley, superintendent of Farm and Trade School, Boston, who gave a very interesting talk on the objects of that institution and the methods employed in educating boys to practical business in the various walks of life.

At the conclusion of the address, the next speaker introduced was Henry F. Clark, of the United States Lighthouse Engineer's office, who spoke largely on the construction of lighthouses and how they are conducted.

BRITISH FOUNDRY PRACTICE.*

By W. G. McIntosh

In preparing a paper of this kind we can but speak of things generally. Even in America, one foundry differs in glory from another, as do the stars in heaven, so in this instance.

Among the first things that catch the American eye on entering a British foundry is the absence of wooden flasks. A wooden flask in Britain would be as much of a curiosity to the molders as the statue of liberty was to the people who saw it drop off the watch guard of Columbus upon his discovery of America. Wood is expensive, and must be kept in constant repair, and is not durable. Besides, with wooden flasks, it requires more time to clamp down and bind together, with the attendant possibilities of straining, or crushing in the side of the mold during binding, while iron or metal flasks are neater, stronger and cheaper, when we take into consideration the constant repairing of the wooden flask.

English Methods of Molding.

Another noticeable feature in the British foundries is the more general use of the bedding-in system. While in many foundries they roll over, which is the best when it can be done, yet in many cases bedding-in is much faster. Wood, as stated before, is very expensive, and there is, therefore, a great deal of loam molding by the use of skeleton patterns. The methods used in making castings in loam differ radically from the methods employed in either green or dry sand molding. A system of building molds with bricks and loam binders is used that would be impracticable in either of the other two branches. This system is used very frequently to save the expense of patternmaking, as molds can, in some instances, be made with sweeps and skeletons, which would require elaborate patterns and core boxes were they made in green or dry sand.

The apparatus necessary for starting a loam mold would be a centering block for guiding the spindle. This block should be made firm or rigid to prevent it being moved at the bottom. The spindle is placed in the block, and also has a guide at the top. All spindles should be turned and should be straight. The diameter of spindle will depend on the character and length of work. Whatever the diameter, it should be in inches, as fractional parts of an inch are liable to confuse some men in making measurements when setting sweeps. The bottom of a spindle can be made tapering for a length of from six to 12 inches, and fitted to a hole in the spindle seat which has a corresponding form. Some spindles are made to revolve when turning the sweep, while others remain stationary. In constructing sweeps they are made with a bevel. Where they are used extensively it is a good plan to fasten a piece of iron to the front edge. Sweeps are generally made of wood, and vary in thickness from one inch to one and one-half inches, according to the stiffness required. In setting sweeps to the right diameter a straightedge with a semi-circular notch equal in radius to that of the spindle, cut into one edge, is used.

Spindle Arms.

Spindle arms are made both of wrought and cast iron, having set screws which permit the sweep to be clamped to the spindle and revolve with it, should it be desired. Where a stationary sweep is required, collars are required to hold the arms from moving up and down. Having fixed the center piece and top support a bottom plate is set on a bearing, the arm and spindle being removed during this process. They are then replaced and the sweep is bolted to the arm in such a position as to give the diameter required. Bricks are then laid in a loam mixture. Considerable space exists between all the bricks, which is partly due to the impossibility of making flush joints with those of rectangular form, and is also partly due to the necessity of having some opening between the joints to act as vents, for the steam and gases. These spaces are filled with cinders, rammed in snugly with the end of a file or flat piece of iron. This is one form of venting loam work that is much used in loam molds. After the spaces have all been packed with cinders, the outer ends and upper faces of the bricks are cleaned free from cinders and a coarse loam is daubed over them, and the whole is swept up, using a fine finishing loam for the last coat. The outside of mold having been built up and swept, a lifting cross and four slings are hitched to the bottom of the handles of plate, which is then wedged to prevent the mold from toppling over when being hoisted. The outside having been prepared, the sweep for forming the center core is set, and it is then built up in the usual way, swept up, and put into the oven.

Loam Molding.

Loam molding demands some skill in bricklaying, as a loam molder often has some difficult work presented to him. The mold having been dried and put together in the pit, the next thing in order is to start ramming up the mold. Where this work is

*Presented at the July meeting of the Cincinnati Foundrymen's Association.

done by hand there are generally from four to eight men needed for ramming. The leader takes the peen end, and is followed up by his men with butt rammers, the bottom course being rammed very solidly so as to prevent straining. As the ramming progresses it is necessary to provide vents to carry off the gases. This is done by laying a course of cinders at various points, leading them to the side of the pit, and carrying them to the top by means of gates, sticks or rods. These rods are pulled up as the ramming progresses, for if they were left till all had been rammed they would be extracted with difficulty. After the outside has been rammed up, sand is rammed in the inside of core to a depth of about one foot. Some molders do not do so, but it requires little time and is a wise precaution that may prevent the casting being lost by the pressure of the metal finding a weak spot in the bottom of the core. The pouring basin is then made, after which it is ready for casting.

Molding Machines.

Regarding molding machines, companies making duplicate parts have them installed, and there are about as many kinds as we see over here. There is a machine often used for the making of gear wheels, manufactured by Whittaker & Sons, of Oldham, Lancashire; another by Buckley & Taylor, of the same town. Twenty years ago a 20-foot diameter gear wheel, having a 14-inch face and 5-inch pitch, was made by a boy of 18 years on the Buckley & Taylor machine, and it was cast at the foundry of Wolstonholm & Rye, of Oldham. The machine is simple in construction, and accurate in work.

There are many kinds of sand mixers used, but the ones commonly met with are the centrifugal, or whizzer, and the oblong double screen shaker. The facing, in almost every instance, is passed through a mill resembling a mortar mill, being mixed with sea coal, old sand and horse manure, before going to the sand sifter or the whizzer. The whizzer, or centrifugal machine, is thought to be best.

Cupola Practice.

Cupola practice is very much on the same line as in America. While many foundrymen depend entirely on fracture for judging the quality of pig iron, together with traditional information, yet large concerns have their chemist or metallurgist, who works in conjunction with the foundry foreman.

England being an old country, it is only to be expected that the American traveler in its foundries, especially in the country districts, where the population is not so cosmopolitan, will find many things that would cause him to smile, inasmuch as some of them climb the fence as their forefathers did, believing it to be the only and best way of doing things. They are prejudiced against new ideas and methods, which they look upon with superstition and consider putting them into practice, almost sacrilege. The American, on the other hand, does not confine himself to local help, that is, men who have been born and raised in the surrounding district of the foundry, for he is aware that many a man who has traveled in various shops knows more than one who has not, and may be able by some simple device to greatly increase his output and profits. It is no unusual thing to discharge a man who presents new ideas or suggestions, even though their benefits or values are inevitably and readily made manifest. Although I say it is not an unusual thing, I would not have you conclude that this characteristic is universally prevalent by any means, but it would be more profitable to British manufacturers, as well as more satisfactory and encouraging to the employe, if the man at the head of affairs, instead of being so autocratic and conservative, were more approachable and receptive.

SEMI-STEEL CASTINGS.*

By David McLain

I shall only give you facts that we found while trying to overcome a rather difficult proposition in our iron foundry. Here I have a sample casting of the job. When I requested our machine shop foreman to allow me to take this casting, I told him what it was wanted for, and asked him what he saw in our semi-steel to condemn, and he said, "Not a thing. Ninety-nine machinists out of 100 would say that it is a good close-grained iron, and would never imagine it is semi-steel."

When we began experimenting with this pattern, our loss was from 40 to 50 per cent, and we had no means of telling how the castings were going to be until after the final operation in the machine shop, when they would be tested at 150 pounds air pressure, and either be accepted or rejected. As these castings, finished, cost our firm $2.52 each, one can see that the loss amounted to quite an item. In this connection I might mention that at that time our machine shop cost was $1.50, as against $0.82 now, due to the adoption of the premium system.

Before this our firm had been buying these castings from local foundries and others, and the loss was always from 40 to 50 per cent. After a considerable length of time we reduced this to 25 or 30 per cent.

We tried charcoal iron, and did everything we could with it. We talked with some of our foundry friends about the job, and tried what they advised, but with no better results. About this time our foundries were overstocked with all parts of our product, with the exception of these cylinder heads, and as orders were slow in coming in, our foundries, iron, steel and brass, were closed, and the cylinder head patterns sent to Michigan, to a concern which made a specialty of this class of work. We thought our troubles were at an end with this job, but it was just the same old story. Castings would look fine, but when tested were no good. We even had a few of the castings fly to pieces while being tested. We took an analysis of the foreign heads, and while the castings were regular in the composition, still the loss would be 50 per cent and over when tested.

The first heat we made in semi-steel was very encouraging to all appearances, but not so in the machine shop. The castings would be hard, or have hard spots in them and so on. There was always something wrong. If the castings were soft they would leak. On some heats we would not try to machine the castings, but discarded them as they were so hard.

After going over the same ground for a couple of months and not securing satisfactory results, we decided to drop semi-steel, at least for the present. The analysis of the metal made averaged within the limits as follows: Silicon, 1.25 to 1.74 per cent; manganese, 0.44 to 0.77 per cent; phosphorus, 0.54 to 0.65 per cent; sulphur, 0.094 to 0.155 per cent.

We then started to make the castings from our regular metal. I always thought it queer that no more attention was paid to the percentage of phosphorus and sulphur that was carried and the way I figured was about this. If one uses a high percentage of steel, he should try and secure as low a percentage of sulphur and phosphorus as possible. Try to get iron, that is, a local foundry iron with these metalloids pretty well

* Read before the Milwaukee Foundrymen's Association.

down. We knew that the manganese would take care of our sulphur, but as manganese converts graphitic carbon into combined carbon, it means that your castings will be too hard. That is the general supposition, and is probably so, if there were no silicon in the metal. But as silicon converts combined carbon into graphitic carbon, and one should aim to carry about 1.75 per cent silicon, let these two metalloids fight it out and see what the results are.

As manganese has a greater affinity for oxygen than for iron, we lost quite a large percentage of manganese, but as it removed the sulphur all was satisfactory. The first heat tried proved a success, and it has been the same ever since.

The analysis of our metal at present is as follows: Silicon, 1.65 to 1.75 per cent; manganese, 2 to 2.50 per cent; phosphorus, 0.45 to 0.50 per cent; sulphur, 0.04 to 0.05 per cent.

It is made of Thomas iron, which I consider the best for semi-steel in this part of the country. We have run as high as 45 per cent steel, and the only danger in carrying such a high percentage of steel is in the handling of the metal. It seems almost impossible to carry such a per cent and still have a nice metal in such a thin section as one-quarter inch in some places.

The plan we always follow in calculating a mix for semi-steel is to take an iron 0.35 to 0.45 per cent phosphorus or lower; 0.025 to 0.035 per cent sulphur; manganese, one per cent or higher. The silicon in our iron varies, but as the amount of silicon determines the percentage of steel, that is all one has to look out for. If our silicon runs two per cent we can carry 30 per cent steel; if 2.25 per cent, then 35 per cent steel, and so on, always watching, of course, that we have 1.65 to 1.75 per cent silicon in our casting. Then we add enough manganese in lumps about the size of an egg to our charge to give about 2 to 2.50 per cent manganese in the casting, always considering that one will lose from one to two per cent in the cupola.

SELLING THE FOUNDRY PRODUCT.*

By Elliott A. Kebler

While much has been written about the importance of keeping the costs of the product of the foundry, the absolute necessity of knowing the approximate cost of castings before bidding on the work has not been sufficiently dwelt upon.

It is the custom of founders to glance at a pile of blue prints, and if they appear similar to work which has been done before, the price is made the same as was obtained for the other work, and too often, when it reaches the foundry, unexpected difficulties arise which add greatly to the cost.

While it is often difficult to have a careful estimate made in advance by reason of lack of time or insufficient data, if a foundryman absolutely refuses to quote until he has made an estimate, he will find in nearly every instance his customer will allow him sufficient time to make his estimate, and his profits at the end of the year will be greatly increased.

To sell satisfactorily a foundryman must know that his estimates are correct, for this will give him a confidence in the price at which he is offering his castings that cannot be obtained in any other way, in fact an estimate which is not afterward verified by the actual cost is of but little value.

As an instance of this, a foundry which based its quotation on an estimate sheet, compiled by its superintendent in consultation with his foreman, adopted one on which the detailed actual cost was also entered after the work was completed, so that at a glance the correctness of each item in the estimate could be seen.

When this new form was first used the estimates were found to have been very unreliable, but after the differences between the costs and estimates had been pointed out, the superintendent and his assistants soon learned to make correct estimates.

A serious mistake is made by some foundrymen who base their quotations on the prices named by others. A mill whose castings, while apparently similar to that of other plants, but were really much more expensive to make, secured its repairs for the first year at less than cost, and continued doing so by placing its orders for succeeding years with different foundries at approximately the same price by showing the bidders the figures which they had paid in preceding years.

In fact unless a foundryman knows by actual experience, or can figure the costs of the castings required, it is very dangerous to take an indefinite order unless a large margin of profit is allowed.

These yearly repair contracts are also unsatisfactory, for if prices of castings advance, the mill may stock up repair parts, while on a falling market, the repairs are often inconsiderable.

As the profits vary on different classes of castings, a foundry salesman should keep constantly before him the desirability of securing orders which will yield the most profit, as his value to the company largely depends on this.

One foundry makes a careful record of this so that a salesman who on a smaller tonnage obtains more returns is appreciated more than a man who fills up the shop on orders which show but little profit.

Too often foundrymen are not sufficiently alert to secure orders for work which they had not previously made, or for which castings might be used.

A foundry salesman overhearing the president of a company telling his purchasing agent that some steel work which they were using was oxidizing rapidly, suggested the substitution of cast iron, and thus secured large orders from this plant and others for a class of work which heretofore had never been made in a foundry.

In fact a decided change has taken place in the art of selling material, and to be a good foundry salesman a man must not only be a good talker, but must be thoroughly conversant with the class of castings he is selling, and often must know how they should be used to get the best results.

As the buyer often relies on the representations of the seller, it is absolutely essential that the latter be honest in his statements if he wishes to hold his trade, in fact a first order often hinges on this very consideration.

Recently a buyer was in the market for some material, and clearly showed the bidders that he wished the material to have a certain peculiar characteristic. He placed his sample order not with those who flatly stated that their material would be as specified, for the buyer knew that the requirements were not fully understood, but with the salesman who frankly told him that he could not promise to fill the bill, but would sell him, subject to a sample which could be tested.

The successful salesman should also know what can be used successfully under varying conditions. He must also keep in touch with the requirements of his customers, for by so doing he may be able to convince them that it is to their advantage to purchase material which under ordinary conditions would be made in their own works.

*Read at the September meeting of the Pittsburg Foundrymen's Association.

GENERAL INDUSTRIAL NOTES

A. J. Detloff, Detroit, has purchased for about $20,000 the building and property at 120-129 Champlain street, and will make fine gray iron castings, and wood and metal patterns.

The Hempfield Foundry Co. has been organized at Greensburg, Pa., with a capital of $45,000, and will erect a foundry at that place for the manufacture of general castings.

The Michigan Gray Iron Casting Co., Detroit, has been organized with a capital of $10,000, by W. L. Coghlin, August F. Meyer and Peter Donnelly.

The National Casting Co., Milwaukee, Wis., has been incorporated with a capital of $30,000. The incorporators are: Edward W. Shallock, Albert W. Lange and H. A. Kirchner.

Articles of incorporation have been filed by the Pittsburg Foundry & Machine Co., Pittsburg, Tex., with a capital of $50,000. The incorporators are: P. W. Thorrell, H. D. Knight, W. C. Hargrove, F. F. Patterson and E. F. Garrison.

The Vulcan Foundry Co., Grand Rapids, Mich., has been incorporated with a capital of $50,000, and will manufacture and sell steam and hot water boilers. The incorporators are: L. T. Peck, E. C. Peck, J. E. Peck and W. H. Jones.

The West Virginia Foundry & Stove Co., Huntington, W. Va., has been organized with a capital of $25,000 by T. N. Boggess, R. H. Armstrong and F. C. Boggess.

The American Chain & Foundry Co., recently incorporated with a capital of $2,000,000, has elected the following officers: President, S. H. Simpson, president of the Michigan Malleable Iron Co.; first vice president, C. S. Santelroy, Chicago; second vice president, W. C. Frye, Milwaukee; secretary and treasurer, A. B. Caldwell, Chicago. The company will have its headquarters in Detroit, where it is expected that a large plant, including a malleable iron foundry, will be erected for the manufacture of conveying machinery.

The Monighan Foundry Co., Chicago, has been incorporated with a capital of $20,000. The incorporators are James M. Proudfit, Fred Larimie and C. T. B. Goodspeed.

The Monarch Foundry Co., Detroit, has been incorporated with a capital stock of $10,000. The incorporators are: John L. Ross, Frank S. Walker and Frank L. Rivard.

The Cascade Steel Foundry Co., Seattle, Wash., has been incorporated with a capital of $200,000 for the operation of an open-hearth steel casting plant. The company will erect a plant near Renton, which it expects to have in operation early in January. The incorporators are: James F. McElroy, Alfred W. Henry and Maurice D. Leehey.

The Michigan Motor Castings Co., Flint, Mich., has been organized to manufacture automobile castings, as a branch of the Detroit Stoker & Foundry Co. Plans are being prepared for a brick building 75 x 300 feet, which the new company expects to have in operation by Jan. 1, with a force of from 75 to 100 men.

The Gardner General Foundry Co., Gardner, Mass., has been formed by the consolidation of the Gardner Foundry Co. and the General Foundry Co. of that city. The two plants will be operated for general foundry work, as heretofore, and no immediate changes or additions are contemplated. The capitalization is $50,000, and the officers are: President, Edward G. Watkins; general manager, Gustaf E. Hoglund; treasurer, Ralph N. Wiley.

The Universal Foundry Co., 738 Broad street, Newark, has been incorporated with a capital stock of $50,000 to operate a brass foundry and pattern shop. The incorporators are: Samuel E. Maylor, Henry Fries and George Hermann, all of Paterson.

The Hardwick-Webb Machine Co., Dallas, Tex., has purchased the Dallas Foundry Co., increased its capital stock from $20,000 to $40,000, and changed the name to the Hardwick Foundry & Machine Co. The company is building a new foundry, 80 x 140 feet, and a pattern shop, 50 x 100 feet.

The Hempfield Foundry, Greensburg, Pa., founder and machinist, has been incorporated with a capital stock of $45,000. No immediate changes will be made in the business, which has been successfully carried on since 1898.

New Construction.

The Wapak Hollow Ware Co., Wapakoneta, O., has increased its capital stock from $50,000 to $75,000, and will erect an addition 60 x 70 feet to its foundry.

The Alabama Consolidated Coal & Iron Co., Gadsden, Ala., is erecting a foundry and machine shop in connection with its furnace plant. The main building will be 75 x 150 feet.

The Armor Steel & Foundry Co., Matthews, Ind., whose plant was recently damaged by fire, is replacing the entire roof of its main foundry building 60 x 225 feet with a steel structure. The loss sustained from the fire was confined largely to the roof but it has not restrained the company from operating. W. S. Freeman is president.

The National Stove Co., Lorain, O., is rebuilding its plant which was destroyed by fire some months ago. The new plant will consist of a main brick building, 60 x 450 feet, two stories, which will be divided by three fire walls, and a brick fireproof building, 50 x 63 feet, for power purposes.

The Vincennes Pipe & Casting Co., Vincennes, Ind., maker of soil pipe and fittings and general castings, is now operating its new plant. It is increasing its molding shop to 150 x 200 feet, and installing another cupola and blower.

The Keystone Steel Casting Co., Chester, Pa., has decided to increase the capacity of its plant to provide for its increasing business. Two crucible steel furnaces and one annealing furnace will be added.

The Keystone Bronze Co., Pittsburg, is erecting an addition, 55 x 110 feet, which will double the capacity of its foundry. The new building, which was made necessary by the company's increasing business, will be of steel construction, and two five-ton hand power Northern cranes will be installed.

Harvey M. Ream, formerly with the Buchanan Foundry at Lebanon, Pa., is erecting a small foundry in Lebanon, for the manufacture of sash weights and light castings.

The Monarch Steel Castings Co., Detroit, manufacturer of couplers and coupler attachments, is erecting two additions, 54 x 100 feet and 40 x 60 feet, respectively, which it expects to occupy Nov. 1. The new buildings will increase its capacity 50 per cent.

The plant of the Sterritt-Thomas Foundry Co., Pittsburg, which was destroyed by fire on May 13, is being replaced by a steel building, 45 x 183 feet, with two lean-tos, each 20 x 183 feet, and a three-story pattern storage house which has just been completed. Two 15-ton electric cranes will be installed. One of the 58-inch cupolas formerly used and a new 72-inch cupola, with a combined daily capacity of about 35 tons, will be used in the new plant.

Charles H. Evered, who is interested in the Wright Foundry & Machine Works, Superior, Wis., will erect a new plant for that company. Plans have been made for a building 105 x 150 feet, which will contain a machine shop and iron foundry, a brass foundry and a blacksmith shop.

The A. Gilbert & Sons Brass Foundry Co., St. Louis, has purchased a site, 75 x 180 feet, on Forest Park boulevard, for the erection of a new brass foundry, which it expects to occupy early in October. The building will be mainly one story, with a two-story front for office purposes, and will have a saw-tooth roof, with 18,000 square feet of skylight. The company will spend about $25,000 on this plant, which will be one of the best equipped brass foundries in the west.

The Pittsburg Foundry & Machine Co., Pittsburg, is erecting a branch foundry at Salem, O., the main building of which will be 96 x 100 feet, and will include, besides the molding floor, the cleaning and core departments. Coke storage and power house will also be built. W. J. Ball has been appointed superintendent.

The Bartlesville Foundry & Machine Co., Bartlesville, I. T., is erecting a foundry, 60 x 80 feet, machine shop, 40 x 60 feet, and several smaller buildings. The company recently increased its capital stock to $30,000.

The South Side Steel & Malleable Castings Co., Milwaukee, Wis., is erecting a foundry building, 76 x 260 feet, and shipping and storage building, 60 x 80 feet. A new melting furnace and annealing oven will be installed in the foundry. The company expects to increase its working force to 300 men and will practically double its annual output.

The Terre Haute Malleable & Mfg. Co., Terre Haute, Ind., has purchased two acres of land in Terre Haute on which it will erect a foundry plant which will double its present output.

The Beatrice Iron Works, Beatrice, Neb., is building a brick foundry, 40 x 70 feet. When completed, it will be equipped with the most modern machinery.

The Virginia Machine & Foundry Co., Virginia, Minn., is building a foundry, 40 x 130 feet.

The Plume & Atwood Mfg. Co., Waterbury, Conn., will erect extensive additions to its plant, consisting of a three-story building 38 x 50 feet, a one-story brick structure 38 x 40 feet, and another story will be added to one of the existing buildings of the present plant.

The Terrell Foundry & Machine Co., Terrell, Tex., whose plant was recently destroyed by fire, will erect a new foundry 50 x 100 feet. One 32-inch cupola will be installed.

The Allegheny Valley Malleable Iron Co., New Kensington, Pa., will place its new plant in operation early in October. Plans are already being prepared for an extension to its plant 80 x 440 feet. The present foundry has a capacity of from 35 to 50 tons a day.

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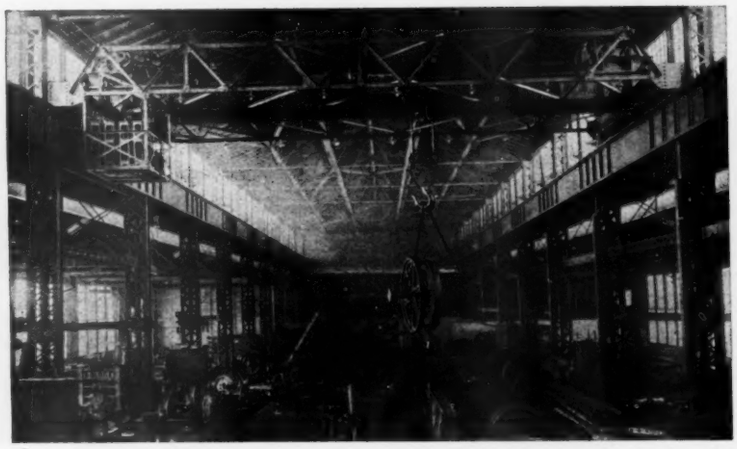

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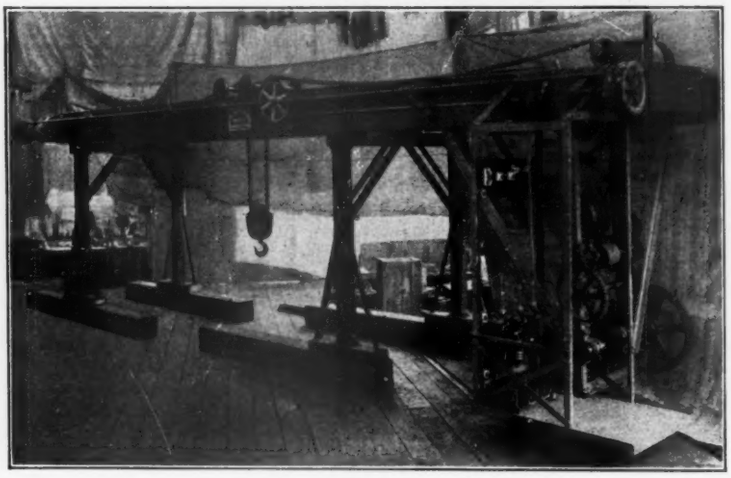

WHERE the head room is limited and the ladle of hot metal comes close up to the bridge, it is desirable to keep the hoist and motor away from the heat. In addition to the usual automatic electric and mechanical brakes the hoist is provided with a hand brake which gives absolute control of the lifting speed from full speed with a full load, to a few inches a minute for drawing patterns.

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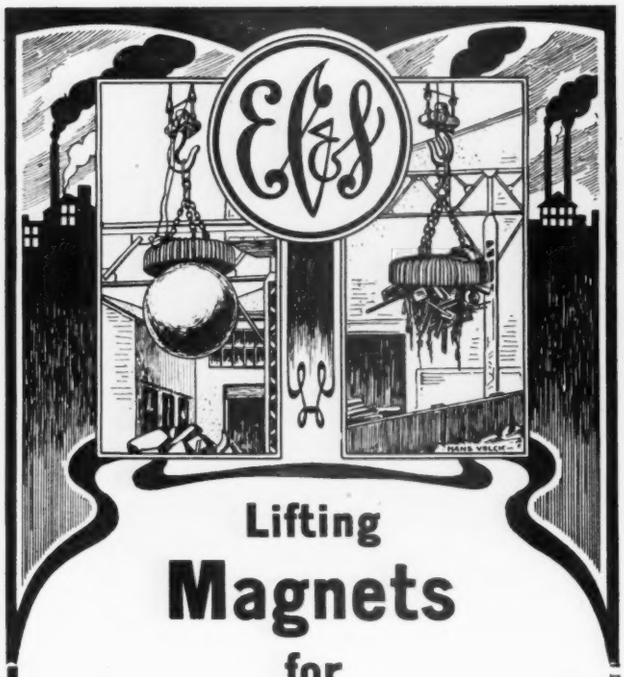
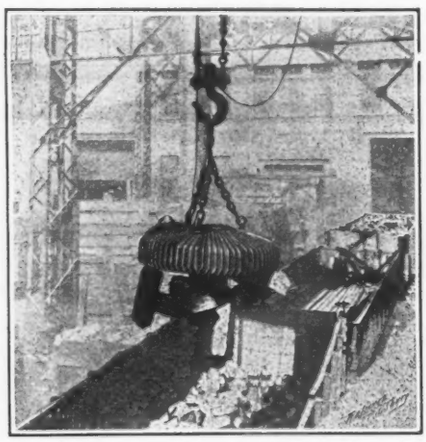


Lifting
Magnets
for
Foundry Uses



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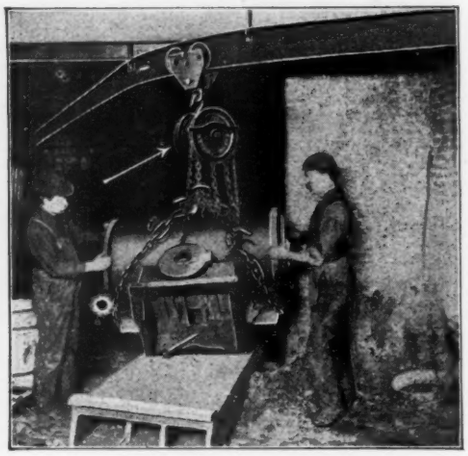

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Questions like these are asked every day in the year, so let's answer them now once and for all.

Without comparing the MOYER system with any other, let's see what there is about it, that brings us so much business.

Let's start with the rail. Just a standard section steel I-beam in good, straight, long lengths—no chance for dust to collect—and you know there is considerable dust in every foundry—the wheel surface is inclined, so whatever dust does settle on it, the trolley knocks off as it passes along.

The weakest point of every system is at the joint. Not in point of breaking, but in wear. That's why our rail lengths are twenty feet wherever possible.

Examine the joints—they are held securely in position by a splice plate, top and bottom. Eight good size bolts hold each plate—can't get away—can't get out of line. All rails are cold sawed exactly square both ways—that's why our joints fit so close.

We realize that the majority of our systems are erected by the customer's own men—that's why our entire lay out is so arranged as to be capable of any reasonable adjustment.

For example—we do not drill the rail for hangers, first it does not add any to its strength to punch holes in it—and, second, we seldom get measurements accurate enough to place holes. By means of our clamp hangers horizontal adjustment is made—the V-hangers give a vertical adjustment.

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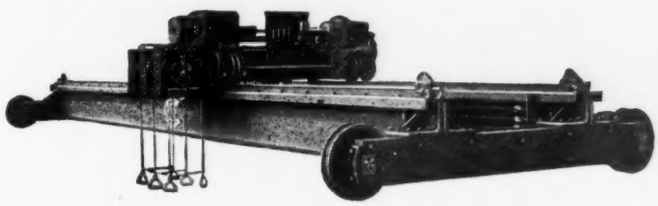

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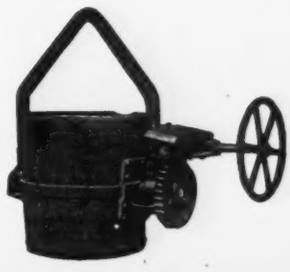

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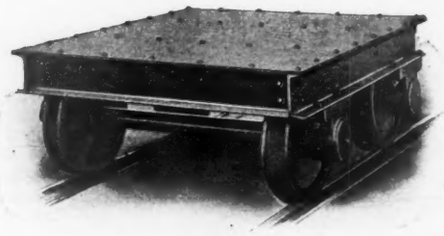

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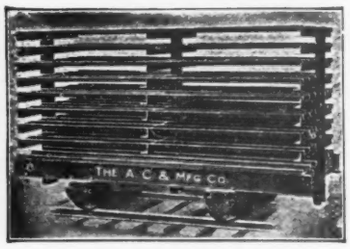

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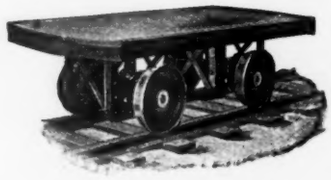

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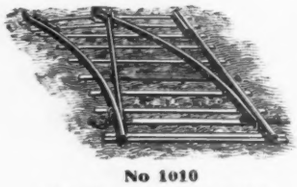

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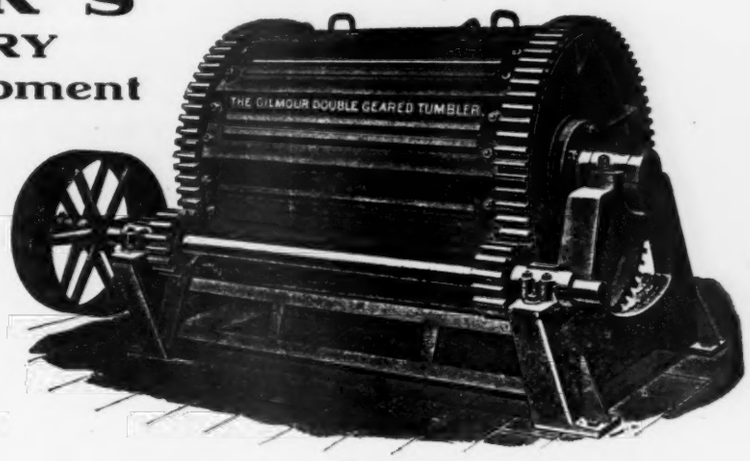

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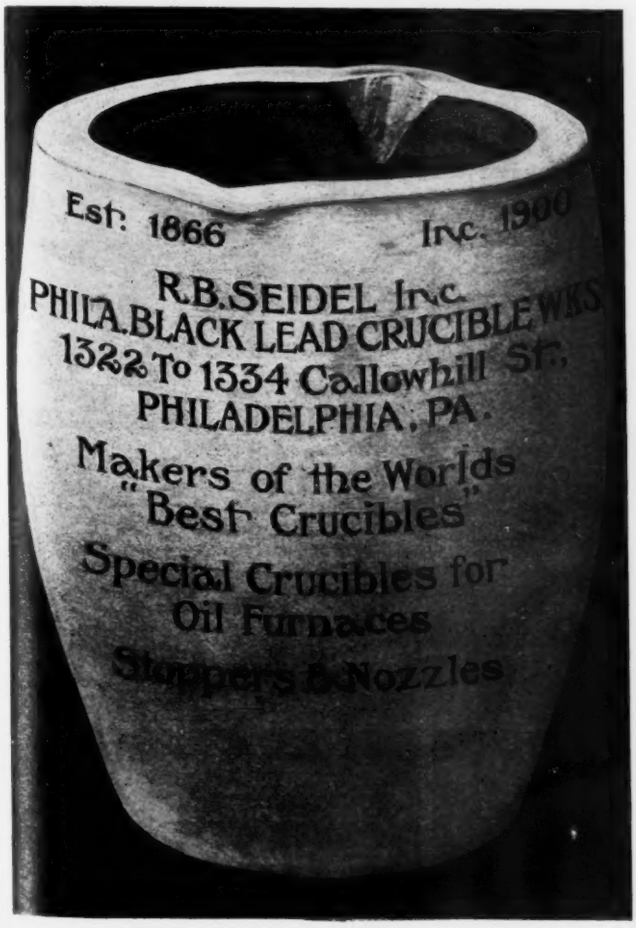

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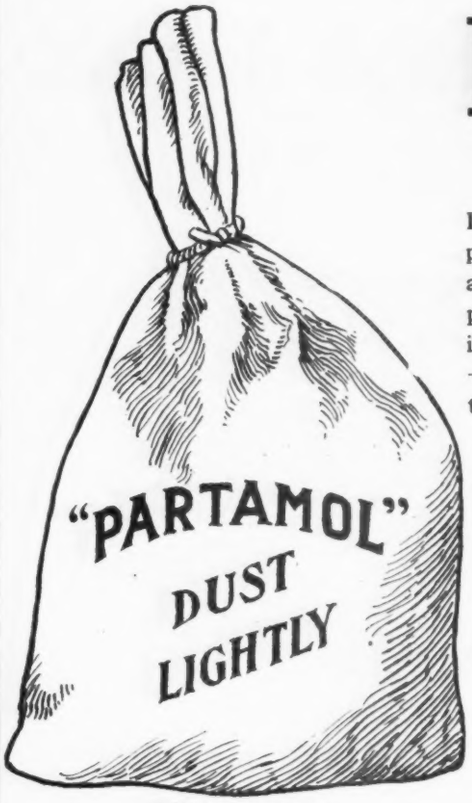

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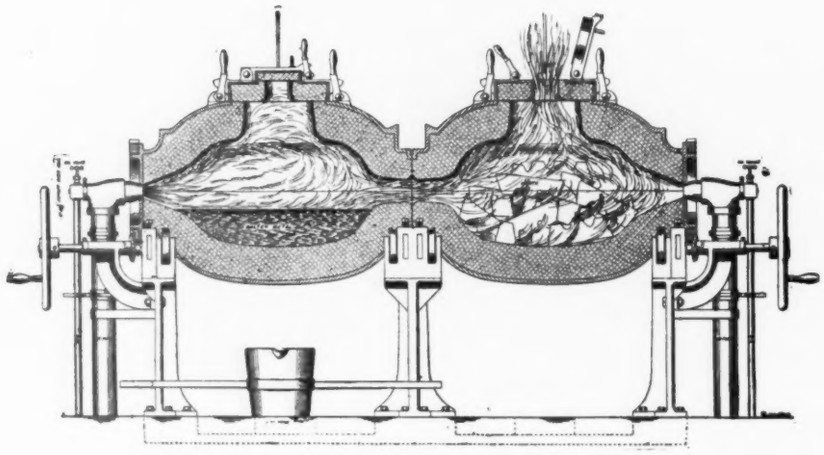

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